THE
TROPICAL AGRICULTURIST

VOL. LVIII. PERADENIYA, APRIL, 1922. **No. 4.**

THE BUDDING OF RUBBER.

In previous numbers of the TROPICAL AGRICULTURIST attention has been drawn to the possibilities of budding and grafting rubber. The local press has given prominence to the necessity of making extensive trials in the work in Ceylon and several estates are now making a beginning.

Budding rubber has been successfully carried out in Java and Sumatra for some years and recently fairly extensive areas of budded rubber have been planted out in the Federated Malay States. One estate in Sumatra is stated to have over 3,000 acres of budded rubber planted out and it is expected that tapping experiments may begin in Java this year on budded plants that are four years of age.

Two passed students of the School of Tropical Agriculture at Peradeniya have recently been sent to Java to gain practical experience of the budding of rubber. One of these has been sent on private account and the other by the Ceylon Rubber Research Scheme. The latter will be employed for some time at the Botanic Gardens, Heneratgoda, and will also be available to estates that desire his services.

It has been shown that the budding of rubber is a practical possibility, that budded plants make satisfactory growth. Goostees from budded plants have also been successfully grown.

The depression in the rubber industry has given rise to a considerable number of proposals for compulsory or voluntary restriction of output until the market demand becomes greater.

The restriction scheme of the Rubber Growers' Association was in force until the middle of 1921, when it had to be abandoned for want of sufficient support.

Some rubber-producing countries capable of turning out rubber at low cost are opposed to restriction proposals and many directors of rubber companies are now beginning to recognise that if the industry is to be unfettered with restriction schemes costs of production must be reduced and the outturn per acre from favoured estates increased.

It is well known that there are certain individuals among the trees of a rubber estate that give yields of rubber greatly in excess of the majority. These trees are known to the estate management and to the tappers. It has also been shown that a good yielding tree is always a good yielding tree, unless it becomes affected by disease. It necessarily follows therefore that if a field could be established with plants reproduced vegetatively only from parents of high-yielding capacity the average outturn of rubber would be considerably increased and its cost of production reduced.

It is not anticipated that the effect of the establishment of budded rubber will be noticeable to the industry for several years. The percentage of the acreage of such rubber to the total rubber acreage will remain infinitesimal for a considerable time. Old estates moreover will be unable to accomplish much as the greater part of their acreage is already fully planted out.

It has also yet to be ascertained what actual yields can be secured from budded rubber and it has to be found out whether such rubber will be more liable to disease than rubber raised from seed.

For the present, Ceylon rubber growers are advised to mark all trees giving exceptionally high yields of rubber and to make experimental trials of budding. Every assistance will be given by the Department of Agriculture to those commencing this work.

RUBBER.

THE VEGETATIVE REPRODUCTION OF SELECTED STOCK OF HEVEA.

J. N. MILSUM, F.L.S.,

Assistant Agriculturist, Department of Agriculture, F.M.S. & S.S.

It is now generally understood that there is considerable variation in the yields of individual rubber trees and it has been found that by means of budding, trees may be propagated with all the visible characters of the parent tree. It is as yet a moot point whether this applies in the case of yield of latex, but it appears possible and preliminary investigations in Java are said to confirm this supposition.

The writer having visited recently the east coast of Sumatra, it appears to be not without interest to record what is being done in this connection, in that country, supplemented with observations gathered from experiments in propagating Hevea at the Experimental Plantations, Kuala Lumpur. It is to be appreciated that as far as the actual practice of budding is concerned, the work is now on an established basis and employed on a number of estates, that are planting rubber. As to whether these areas, when in tapping, will give the yields that are anticipated is a matter for the future.

PRELIMINARY INVESTIGATIONS TO DETERMINE HIGH YIELDING TREES.

This matter is more complex than is often supposed as so many factors may influence the yield of latex. In the first instance it is uncertain to what extent latex production is a hereditary character. Secondly, whether the yield of latex from any individual tree is constant and not variable according to age and external conditions. A further consideration is what relation may exist between the root of the stock seedling and the eventual yield of the budded tree. It is evident that more research is necessary to enable these questions to be answered with precision.

Very considerable efforts are being made in the Dutch East Indies to ascertain which are consistent high yielding trees for the purpose of providing stock for future planting. In this connection the patient work of the Cinchona planters in Java may be mentioned, where by a long series of selections, strains of Cinchona trees have been obtained and reproduced vegetatively with a considerably increased percentage of alkaloid in the bark. No analogy can be made between yield of quinine and latex production as the means of extracting the product are so widely separated but it does seem possible that the methods employed in Java with Cinchona attended by such marked success may be applicable in the case of Hevea.

To collect data for furnishing evidence as to the heaviest yielders on an estate, the following method is employed. A special gang of coolies follow the tappers and measure the latex from each tree once a month. Glass tubes graduated in six divisions and marked with a simple sign to indicate six

classes of yielders, are issued to the gang. The sign representing the volume of latex is then marked on the tree with a tapping knife. A vertical series of twelve such signs thus indicates the yields for twelve monthly measurements. Six measurements are said to be sufficient to indicate the lowest yielders but the longer the yields are taken the more reliable is the information obtained. It must be borne in mind that disease stimulates the flow of latex, so it is important that sufficient time elapses to ascertain whether disease is present or not. The trees finally selected are marked with a band of paint.

More precise information may be obtained by marking out the trees that have been found to be consistently the best yielders and after coagulating the latex on at least two occasions a month, recording the average dry weight over a period of one or more years.

Let us assume that a number of trees have been selected as the heaviest yielders on any particular plantation. These trees will provide the material for future planting and it is then necessary to raise nurseries of seedlings as stocks for budding from the selected trees.

SEED FOR STOCK PLANTS.

In selecting the seed for the stock seedlings the principle of improvement should be borne in mind and only seed from healthy and high yielding trees be collected. It should be appreciated that seed from such trees are likely to show considerable variability on account of their unknown parentage on the male side. HEUSSER* has shown, after many experiments with artificial pollination, that Hevea is adapted for cross-pollination and is not absolutely self-sterile, but usually 'selfing' is unsuccessful. Even should it be possible to ensure pollination of the female flower by pollen from male flower of the same tree, the offspring will still show variability account of impurity of strain brought about by possible cross pollination in the previous generation.

NURSERIES.

The nursery beds should be laid out from East to West and be about 4 feet wide. The seeds are planted in rows 1½ feet apart either way, thus allowing plenty of space to work in during budding operations.

TIME FOR BUDDING.

Seedlings are considered to be a suitable age for budding when six to nine months old, according to growth. Seeds sown during September produce stumps ready to be budded the following May. Generally the period from the termination of the wintering period to the autumn rains is the season for budding. Further experience is necessary to determine the best months for budding operations in this country.

PREPARATION OF THE MATERIAL.

A good material for the binding cloth is ordinary unbleached cotton cloth which is readily procurable from native importers. The cloth is obtainable 34 inches wide and may be cut into two strips of 16 inches wide and is then ready for waxing. Other sizes are procurable but it is most economical to have a cloth of sufficient width to strip into two. After waxing, strips of material are cut off measuring 16 inches by one inch. One yard of

* ARCHIEF VOOR DE RUBBERCULTUUR, December, 1919, p. 455.

cloth provides material for binding up 70 stocks. Should binding cloth be required for older stumps, then the strips will have to be correspondingly larger.

Several mixtures have been recommended for waxing the cloth but when tested at the Department of Agriculture, were found unsuitable for general use. The following ingredients made a good wax and so far appear to be the most suitable, though other cheaper grades are satisfactory.

Fifty per cent. Petroleum Jelly (Paraffinum molle flav).

Fifty per cent. White Paraffin Wax (Melting point 125/30 degrees F).

These materials are obtainable in quantity from local firms at the following prices :—Paraffinum molle flav, 70 cents a lb., White Paraffin Wax, 15 cents a lb. ($19·50 a picul). These two ingredients are melted down in a kerosene tin over a fire, and after a thorough mixing the solution is ready for waxing the cloth and is removed from the fire. A convenient size for the cloth is 16 inches wide by 10 yards long. This, when rolled up, is immersed in the liquid wax and kept moving for 10 to 15 minutes to ensure thorough saturation. The cloth is then unrolled in the solution and hung over a frame in a cool shed to dry, when it is rolled up and ready for cutting into strips for use. One pound of the mixture is sufficient to wax one roll of cloth. The actual costs of this waxed cloth are as follows :

	$	cts.
Strip of cloth, 16 inches by 10 yards	2	00
Half lb. Paraffinum molle flav at 70 cents per lb....	0	35
Half lb. White Paraffin Wax at 15 cents per lb. ...	0	08
	2	43

A roll of cloth is sufficient to make 350 binding strips, so that the cost per strip works out at approximately seven-tenths of a cent.

It is essential to have a good sharp knife. The large types of budding knives as used in Europe are suitable, though other patterns are also satisfactory. A hone should be kept handy and care taken that the edge of the knife is keen during use.

BUDDING.

As previously indicated, it is considered that the most satisfactory method of reproducing Hevea vegetatively is by budding on the young seedling trees that are still in the nursery beds. The details of this operation will, therefore, be described fully and brief reference made only to other possible forms of a sexual reproduction.

A rectangular tongue of bark, from 1½-2½ inches long by about 1/3 the circumference of the stem is lifted and a bud of approximately the same size from a selected tree is inserted beneath. This is then bound up with the waxed cloth and rubbed over gently with the hands to cause the wax to become softened and adhere to the stem.

It is important that the bud be attached to the stock as near to the ground as possible and that during the operation, speed and cleanliness be ensured.

To prevent the latex forming a film over the exposed cambium and thus preventing the proper union of the stock and scion, it is necessary to outline the incisions a short time before the bud is actually removed and inserted

beneath the tongue of the bark of the stock. About 25 of these incisions may be made before the workman returns to prize up the bark and insert the bud. The bud is situated above the leaf scar. It should be cut from the branch with a portion of the bark above and below it. Any wood adhering to the bud should be removed.

Only mature bark should be used as scions and it should peel easily from the branches of the parent tree. The branches should be removed from the tree early in the morning and be cut up into short lengths and stored in kerosene tins and covered with damp sacking to prevent evaporation.

After two weeks from the time of budding the binding may be removed for the purpose of testing whether the bud has 'taken' or not. To make this test the bark of the bud should be slightly scratched with a knife. Success is indicated by the tissue beneath the cork layer showing green; when black or brown the bud is dead. Failures may have another bud inserted on the other side of the stock and be treated as before.

Those stocks on which the buds have 'taken' are left for a week or more when they are cut back to within about six inches of the living bud. Should the stock be not cut back the bud will remain dormant and refuse to grow. Care must be taken that suckers do not sprout from the stock; should they appear they must be removed early to throw all the vigour of the stock into the bud.

COSTS INCURRED IN BUDDING STUMPS.

Until the coolies engaged in budding have had considerable practice, it is unlikely that they will exceed budding 200 stocks during an eight-hour day. A skilled workman will be able to do 250 in a day and possibly more. The costs in connection with the operation work out approximately as follows:—

Two hundred budded stumps less 10 per cent failures=180 stumps from a coolie earning 45 cents per day	·25	of a cent
Cost of waxing cloth	·70	,,
	·95	,,

or 10 per 1,000 stumps.

There are certain additional charges that must be taken into consideration, but it is a matter of some difficulty to estimate for such as selection of wood for budding, collection and transport to the nurseries, unbinding the waxed cloth, cutting back the stock after the bud has 'taken,' and finally the additional care of raising the seedlings and transporting the stump to the clearing.

It is usual in Sumatra to pay the coolies employed in budding a small sum according to results in addition to their ordinary wages. In all probability, Chinese will make the best workmen in this country and though they will require a higher wage, will turn out a greater number of budded stumps. It is advisable to have a small nursery of stumps set aside for the purpose of training fresh coolies.

SUBSEQUENT TREATMENT.

It is as yet a matter of some uncertainty as to the best system to be adopted to establish the stumps in the field after the buds have been grafted

on successfully. The two principal methods are :

(1) Transplanting the stumps to the field while the buds are still in a dormant condition.

(2) Allowing the buds to develop in the nursery and planting the stumps in the clearing with several inches of growth from the attached bud.

In the first instance it is claimed that the operation of transplanting results in the buds sprouting earlier and the stumps becoming established sooner in the field. On the other hand it would appear that it is advantage to have the stumps properly developed prior to planting to ensure a regular stand of sound trees. Further experiments are necessary before definite recommendations can be made, but it is hoped that this information will be available in the near future.

BUDDING STUMPS IN THE FIELD.

This system is not to be recommended on account of the difficulty in securing a regular stand of budded trees. A less number of "takes" are obtained when the stumps are budded in the open field on account of exposure to the sun and air. Similar conditions to that obtaining in the nursery may be secured by planting two or three tapioca cuttings around each stump, but this means a considerably added expense. The cost of budding is increased because of the greater area the coolie has to cover.

OTHER FORMS OF BUDDING.

Patch Budding.—A rectangular patch of bark about two inches by half an inch is removed from the base of the stock and a similar sized patch from the selected tree is inserted. It has been stated that on anatomical grounds, patch budding has certain advantages over other methods, the principal of which being quicker union of patch and stock. It is possible to have special knives made that work to a scale and ensure the bud patch being exactly the same size as the piece of bark removed from the stock.

GRAFTING.

Mass records* success with grafting ranging from 40 per cent. successes in the case of cleft-grafting, to 55 per cent. with side-grafting, up to 75 per cent. with crown-grafting. It is, however, considered to be too troublesome an operation to be of practical value and in view of the success with budding, unnecessary.

PROPAGATION BY CUTTINGS.

In 1919, the writer carried out a series of experiments for the purpose of ascertaining the possibilities of propagating Hevea by cuttings. Wood in various stages of development was used but in no case was more than five per cent. of 'takes' recorded. The experiments proved conclusively that under ordinary conditions, propagation by cuttings is unsatisfactory.

Burkill† records that out of 1,489, 1–2 inch stakes placed in the ground during January and February, 1917, only 18 or 1·21 per cent. took root and produced leaves. Experiments with cuttings from young twigs were without success.

Similar results were obtained by Mass‡ in Sumatra though he states the

* Archief voor de Rubbercultuur, August, 1921, p. 279

† Garden's Bulletin, S.S., Vol. II, p 54.

‡ Archief voor de Rubbercultuur, August, 1919, p. 286

better results were obtained by ringing the stem prior to severing it from the parent tree. Further, he recommends placing the cuttings deep in the soil and waxing or tarring over the cut surfaces.

Experiments at the Experimental Plantations here, have shown that often good success may be obtained by marcottage, especially in the case of young trees that are marcotted near the ground level. The operation consists of ringing the stem of the young tree as near the ground as possible and placing an earthernware pipe round the stem. The receptacle is then filled with sandy soil and kept in a moist condition. Roots are produced in from two to three months; the stem may be severed and the tree removed a month or so later. Several lateral shoots are produced from the stump, which in turn may also be rooted.

It is more difficult matter to marcot the upper branches of an older tree, mainly on account of keeping the soil surrounding the ring in a moist condition. An experiment is being conducted to ascertain what degree of success may be obtained by this method. A platform is constructed in the branches of the tree and the soil surrounding the marcot kept moist by daily watering, using a small tin above each ball of soil as a supply.

ARENS has recently published a paper* in which accounts are given of the behaviour of several areas planted with 'gootee' layerings of Hevea. In the majority of cases the results were good, so much so that one estate is adopting this method for future planting. On this estate, the trees from layers reached the tappable age six months earlier than was the case with seedlings and gave a greater yield, presumably on account of the layers having been taken from selected trees. On one estate, with heavy clay soil, many layered trees failed to grow upright and were difficult to tap on account of the leaning position of the trees. DR. ARENS concludes that layers are satisfactory on ordinary soils that are not too wet, provided that the layers have a good root system before planting.—AGRIC. BULL. OF F.M.S., VOL. IX, No. 2.

BUD-GRAFTING OF RUBBER.

A. C. TUTEIN—NOLTHENIUS,

Superintendent, West Haputale Estate, Ceylon.

Within recent months considerable interest has been taken in the possibilities of budding and grafting rubber and perhaps the following resumé taken from an article appearing in the ARCHIEF VOOR DE RUBBERCULTUUR for November, 1921, may be of help and interest to those who are keen to experiment or at a loss to know which method of grafting gives the best results.

Perhaps it is too little known that bud-grafting of rubber has been done during the last few years over a very considerable acreage in Sumatra and Java, and although opinions differ and a discussion on the advantages and objections is out of the scope of this small article, has met with success. We are not in a position to publish private acreage figures, etc., but it is of interest to note that on one estate alone already 3,000 acres have been grafted while another 3,000 acres are in hand.

---

* ARCHIEF VOOR DE RUBBERCULTUUR, July 1921, p. 382.

As is known, many different kinds of plants, shrubs and trees can only be propagated true to type by budding or grafting, and from experiments made we may conclude that *Hevea brasiliensis* in all probability belongs to this class.

Graft propagating *alone* will give us *the* type of the parent tree. Trees grown from seed differ greatly and perhaps it is no exaggeration to say that at present there are as many types as there are rubber trees.

Grafting alone can give us *the* type.

While there are several methods of grafting and budding we may say at once that the method of patch-budding* has proved to be most successful and we will content ourselves by describing this method as practised now in the field on a big scale.

PARENT TREES.

It is of the utmost importance that the parent-tree, the tree from which our future type will be propagated, agrees with the following conditions :—

1. Belongs to the smallest number of the best yielders on the estate.
2. Is young and in good vigour.
3. Belongs to the best grown and developed trees.
4. Is free of disease and never having been known to have suffered from Brown bast.

Each parent tree will yield an average of 1000 buds suitable for grafting. Taken at 60 % of successful graftings, one parent tree can give 600 grafts or about sufficient for 6 acres at 100 trees per acre. Only a very small number of parent trees being necessary for an average estate, selection can be carried out as fine as possible.

Most estates have begun to keep yield records for each individual tree, so it should not be difficult to find which trees are the best yielders.

If tapping was started on trees four years old and yield measurements recorded during the 5th and 6th years, we will have 7 year old parent trees, which on good soil ought to be in the prime of health and at their best growth. (All trees with brown bast of course excluded.)

Good yielders, not attacked by brown-bast, prove that although not being entirely immune, they possess a good power of resistance and from such trees off-spring must be obtained while later on it can be proved if these parent trees really are immune for some reason or other.

Other characteristics must be judged with the eye and only the best developed trees will be selected to play the part of parent tree.

The thin branches of the parent tree should only be taken for budding purposes on 6-9 months old stock-plants, while thicker branches can be used for trees up to two years of age.†

The parent tree having been lopped, will throw out many new shoots which after having been thinned out, again will give us valuable grafting-material.

When cutting the branches, care should be taken to see that a good clean cut is made, to be covered with wound-paint or tar.

No lopped parent tree should be tapped for at least three months.

---

*Patch budding also appears to give the best results at Peradeniya.—T. H. P.

† A good guide is to select branches giving a bud sheath of equal thickness to the bark at base of stock plant.—T. H. P.

GRAFTING MATERIAL.

Before cutting the necessary branches from the parent tree, we must see that they are useful for the purpose.

During wintering the bark is dry and peels badly. Cut a small piece of bark and try if it peels off easily, and if the cambial layer is damp ; if so the parent tree can be used, otherwise another parent tree must be selected.

The lopped branches are most easy to handle when cut into pieces of 3 feet length and placed in kerosene oil-tins filled, about 3 inches high, with water.

In this manner a big quantity of material can be collected at once and stored away in a dark, cool place. Good thick branches will keep, up to 14 days, without any failures being noticed, thin branches dry quicker. Storing in wooden cases filled with saturated saw dust has proved most successful in the case of transport.

The number of buds on branches cut in lengths of 3 feet, varies considerably, from 5 to 40 having been found, but as a rule good cuttings will give up to 20 buds useful for our purpose.

During the grafting, the branches are kept in tins with water in a shady spot. Care should be taken not to take buds from the ends, the top being too dry, the other end placed in the water, too wet.

STOCK PLANTS.

Experience has proved that seedlings and young plants up to one year old, give the best results.*

Although propagation by budding or grafting gives us trees not grown from seed, it is necessary to select good seeds for the stock plants to be used, as the stock may have an influence on the future tree.

No records are known as to the influence the stock can have as to yield of the grafted tree, but it is very certain that a well-grown healthy stock will give a well-grown healthy tree while a weak stock will reduce the growing power of the future tree.

It would take us too far to give different instances and examples of the influence the stock plant can have on the graft, while very little is really yet known as to the cause.

In selecting seed for the nurseries, care should be taken to collect seeds of one tree at a time. As is known all seeds of one tree are about the same in size, colour and marking. After a little practice a cooly will be able to sort a consignment of seed into as many heaps as the number of trees the seeds were collected from.

If possible the seed should be plucked when ripe, not collected from the ground, this is of great importance for an even and successful germination. Where it can be done, all seed should be shelled (a pair of nut-crackers is very useful) before being put out, when a 100 % good germination can be expected.

The nurseries are made in the ordinary way, the seeds covered with damp sacks, the beds shaded with cadjans, etc., etc.

Only the best plants in the nursery will be selected as our future stocks in the field.

---

* At Peradeniya approximately 18 months.—T. H. P.

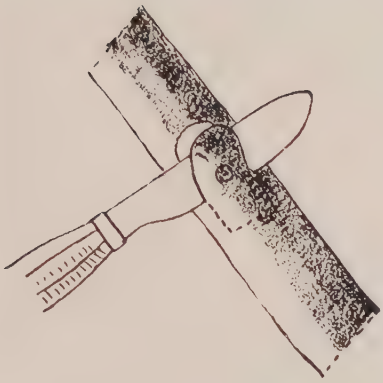


Fig. I
Showing patch with bud being cut off branch

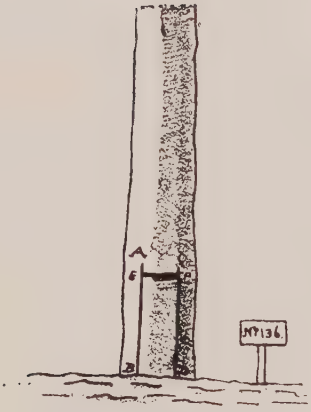


Fig. II
Showing incision on stock

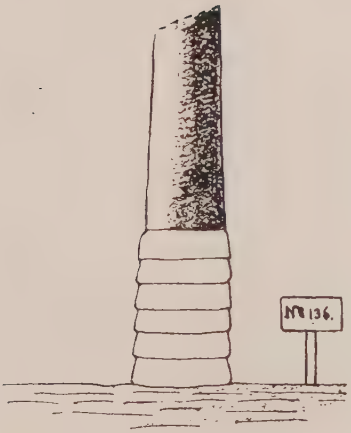


Fig. III
Bandage in position.

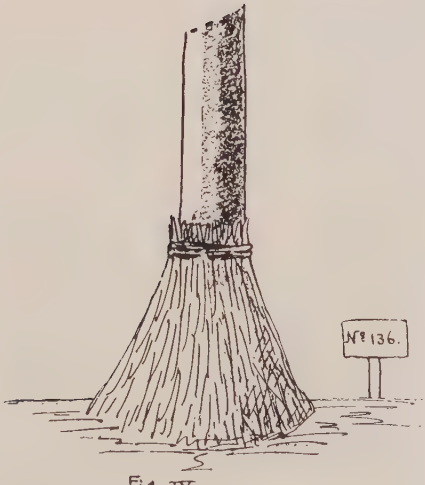


Fig. IV
Mama Grass or Straw screens.

Fig. 3. Removing bark from stock.

Fig. 4. Putting in patch.

Reproduced from Archief voor Rubbercultuur, November, 1921.

NECESSARY IMPLEMENTS.

After many experiments, it has been found that the American-made grafting knife "Keen-kutter" or cotton-knife is the most suitable for our purpose.

The binding material or bandages to be used are most easily and economically made from cheap "cheese-cloth" (the tamil cooly's vetty), dipped into melted paraffin-wax, and then torn into strips, ½ yard long by 2 inches wide. The paraffin should be of low-melting point, so that when the bandage has been placed, the wax can be smoothed down with the hand, preventing rain-water, running down the stem, tickling in and under the bandage.

It is of great importance that everything should be done as clean as is possible. Dirt and sand adhere very easily to the wax or the cooly's hands. He should be given a piece of cloth with which he can wipe his hands and knife after each operation.

METHOD OF BUDDING.

The most practical method giving the best results is patch-budding.

The cooly, carrying his tin in which the branches are, selects one and after having found a good bud, cuts a small patch together with a thin scale of wood which must be left on the patch for the time being. (fig. 1.)

Having cleaned the stem of the stock plant of sand, mud, etc., two vertical cuts are made, distance apart about the width of the patch cut, and about 3 to 4 inches above the collar of the stock. (see fig. No 2., A–B, C–D)

A horizontal cut (E-F) is then made and the bark carefully lifted up at the corners and stripped down, using the fingers only. The strip is NOT cut off.

The greatest care should be taken to touch the cambial layers as little as is possible. The best manner to prevent the patch becoming dirty or infected, is for the cooly to hold it lightly between the lips when making the incision on the stock.

There is no need at all for the patch to fit exactly in the incision made, in fact in Hevea grafting the patch should be slightly smaller than the incision.

The main principle in bud-grafting is to see that the cambial layers are in absolute contact, the bark-union is a secondary matter.

An advantage is that, if the bark of incision and patch do not fit exactly, there is room for the latex to run away so that coagulation under the patch, as soon as it has been pressed tight, is prevented.

The inserting of the small patch must be done as quickly as possible while the cambial layers on no account must be rubbed.

Holding the patch with one hand, the strip of bark left can be covered over and the grafting can be bandaged with waxed tape in the ordinary way. The idea of leaving the strip of bark is to get as tight a bandage as is possible as more often than not the bark of the patch is thinner than the bark of the stock, so the patch would be lower and the surface uneven.*

Method in short:—

1. Clean the stem of stock plant, (sand, mud, etc.)
2. Cut the patch with bud, leaving small shaving of wood.
3. Cut the vertical incisions A-B, and C-D in the stock.
4. Carefully lift the small shaving of wood from the patch and see that the "soul" of the bud has not been removed or damaged.
5. Cut E-F and strip the bark down with the fingers.
6. Place patch in position and cover with slip of bark.
7. Bandage and rub the wax into a smooth surface.

* When young thin bud sheaths are used.—T. H. P.

After having cut E-F, the bark must be lifted at once and patch placed in position so as to prevent latex soiling the cambium.

No grafting should take place during rains.* After rain all stock plants should be cleaned, mud and sand rubbed off before budding is undertaken.

It is desirable to do the work as shaded as possible, the cooly always working with his back towards the sun. The tins with cuttings can be covered with a sack or a mat while the stock, the operation having been completed, can be shaded for some days with a small screen made of grass or palm leaves. (fig. 4.).

Twenty days after the budding has taken place, the bandage can be removed and the strip of loose bark cut away. The grafting being a success the bark of the patch will show green when scratched.

Stock plants, where the grafting has been a failure, can be re-budded if the incision made the first time did not take up more than half the circumference of the stem.†

Again 10 days later the plant should be cut off, leaving about one foot of stem above the bud.

The stock must be cut off clean, no tar or other covering used as the part above the budding must be allowed to die back when it can be broken off or sawn, when too thick.

All small shoots or buds appearing on the stocks must be removed so as to force the new young bud to sprout. The difference between the "false" buds and the grafted bud is easily noticeable, the former being of a light to dark-brown colour, the grafted bud being light green.

Some of the buds will start sprouting 14 days after the grafting but as a rule only after two months, while a few will even take as long as five to six months.‡

"UNDERCURED" SMOKED SHEET.

R. O. BISHOP, M.B.E., A.I.C.,

Acting Agricultural Chemist, Department of Agriculture, F.M.S. and S.S.

Under the title of "Undercured Rubber" the problem of moisture in smoked sheet has been receiving attention recently in the periodicals devoted to the interests of the rubber industry, and reference to the Tin and Rubber Journal of 15th June will show that there is a considerable difference of opinion as to the justification of the claims made by the brokers in Singapore.

For the investigation of claims arising in connection with so called "undercured" sheet the examination of a series of samples was carried out by the writer in October, 1920, at the original request of the Chairman of the Singapore Chamber of Commerce. Since then many other samples have been examined and several reports have been issued in connection with the work carried out. It appears now that a useful purpose might be served by summarizing all the results obtained and permanently recording the observations which have so far been made on the work already performed.

*Light showers, however, appear to be favourable to the operation.—T. H. P.

† Provided the second budding is done without loss of time, otherwise the bark has a tendency to harden and does not peel easily.—T. H. P.

‡ After 2 months at Peradeniya.—T. H. P.

Having defined an under-cured sheet as that which possesses more internal moisture than a correctly cured sheet (N.B. The term has also been used previously in connection with a light coloured smoked sheet) it was established by the rubber appraisers, and upheld by the Singapore Chamber of Commerce, that under-cured rubber could be distinguished by the opacity exhibited at a freshly cut section when viewed against bright daylight.

It was asserted that any samples of smoked sheet giving a plainly marked opaque section were abnormally damp, would develop mould, and also would give unusual trouble to the purchasers when the rubber come to be manufactured into the vulcanized commodity.

The investigation, therefore, resolved itself into a determination of the relative amounts of moisture in smoked sheet as it is normally prepared, and then an examination of the effects which those percentages of moisture would have on the ultimate properties of the rubber concerned.

RELATIVE AMOUNTS OF MOISTURE IN CORRECTLY "CURED" AND IN "UNDERCURED" SMOKED SHEET.

Methods of Determination of Moisture.

In the original instance thirteen samples of sheet were examined. The moisture was determined by two methods.

By the first method the sample cut to a standard area of surface was suspended from a glass rod over calcium chloride in a vacuum desiccator. The desiccator was kept in the dark and all weighings were made on the samples at the same time of day so that any error due to variable atmospheric humidity would be eliminated as far as possible. Moreover as the weighings were done in fairly rapid rotation, surface absorption during weighing should be the same for all samples.

By the second method drying of the standard sized sample was accomplished by suspending it in a current of dry air at 80°C in the dark.

In the case of both methods the samples were weighed every 24 hours until no further loss in weight occurred. The maximum loss was expressed as a percentage on the original weight and described as "Total Moisture."

It must be noted that as the smoked rubber contains certain absorbed and absorbed volatile smoke products the figure for total moisture will be too high by the amount of such volatile matters originally present.

Having dried the samples to minimum weight they were then allowed to remain in the air for 24 hours under protection from dust, etc., and all samples were then retained in a desiccator until it was possible to expose them all to the air during the same 24 hours. Thus the humidity of the atmosphere had the same effect on all. The difference between the weight before exposure and the weight after exposure is expressed as a percentage on the original weight of the sample and is described as "External moisture."

The difference between the "Total moisture" and the "External moisture" is described as "Internal moisture" and is a measure of the under-curing of the sample.

For the purpose of the subsequent discussion of results the samples examined have been arranged according to the degree of opacity which they

exhibited, the arrangement being made by an impartial observer.

Sample No.	Loss by desiccation at ordinary temperature "total moisture."	Moisture taken upon exposure to air "surface moisture."	Difference "interior moisture."	Average.	Loss at 80°c in current of dry air "total moisture."	Moisture taken up on exposure to air "surface moisture."	Difference "interior moisture."	Average.
				No opacity.				
1	0·53	0·43	0·10	0·10	0·65	0·48	0·17	0·17
				Very Faint opacity.				
2	0·68	0·48	0·20		0·76	0·51	0·25	
3	0·59	0·46	0·13		0·63	0·46	0·17	
4	0·62	0·49	0·13	0·15	0·73	0·56	0·17	0·20
				Slightly More Opaque.				
5	0·46	0·39	0·07		0·48	0·34	0·14	
6	0·63	0·49	0·14		0·66	0·47	0·19	
7	0·53	0·43	0·10		0·65	0·48	0·17	
8	0·57	0·45	0·12		0·86	0·68	0·18	
9	0·56	0·43	0·13	0·11	1·26	0·91	0·35	0·21
				More, but not Pronounced Opacity.				
10	0·57	0·45	0·12	0·12	0·63	0·42	0·21	0·21
				Pronounced Opacity.				
11	0·85	0·64	0·19		0·89	0·76	0·13	
12	0·54	0·43	0·11	0·15	0·59	0·47	0·12	0·13
				Very Pronounced Opacity.				
13	0·54	0·32	0·22	0·22	0·62	0·46	0·16	0·15

The average for internal moisture on the complete series of samples is 0·18 per cent.

From these figures it was apparent that the total volatile matter present in smoked sheet was of the order of 0·6 per cent. and of that total approximately seventy-five per cent. was held at the surface of the sheet. The average figure for the interior "Moisture" even when the samples were dried at 80°C. was 0·18 per cent. only.

As was to be expected the heating of the rubber result in a greater loss than by desiccation at atmospheric temperature, but although this heating was as intense as the maximum reached in working up raw rubber for subsequent vulcanization the total loss of volatile matter amounted to 0·71 per cent. on the average and in one case only was above 1·0 per cent. Ref. Archief VV 1921. "Moisture content of inner and outer layers of smoked sheet" by van Heurn.

Another point which was obvious was that the slight differences in moisture content, total or internal, did not bear any relation to the opacity of the interior of the sheet examined.

The results which have been obtained in this series are in agreement with the figures derived from several isolated examinations of smoked sheet but it was not considered that a definite confirmation had been obtained until a second long series of samples had been examined.

Eighteen samples were eventually submitted by the Orient Co., of Singapore and were examined in conjunction with pieces of unsmoked sheet and No. I crepe. Before sending the rubber for examination it had been classified in Singapore by the "Opaque appearance" method and for

every sample having the correct internal appearance there was a corresponding sample from the same estate having an internally opaque appearance and consequently characterized as internally moist and under-cured. The "dry" samples were numbered 1, 2, 3 and 4, etc., the "wet" samples were numbered 1a, 2a, 3a and 4a, etc.

The method of examination adopted was the desiccation at atmospheric temperature, care being taken that all samples should be treated exactly alike. Desiccation was continued for the same length of time—288 hours—but it was found that much shorter periods were sufficient to reach the maximum loss in the majority of cases. When the samples had all lost their maximum amount of volatile matter the increase in weight after exposure to atmospheric conditions was determined as before.

RESULTS.

Sample		Time taken to reach minimum weight.	Total loss of weight per cent.	Internal moisture per cent.	Surface moisture per cent.
Smoked Sheet.	1	96 hours.	0·41	0·16	0·25
	1a	72 ,,	0·42	0·07	0·35
	2	48 ,,	0·45	0·02	0·43
	2a	96 ,,	0·69	0·28	0·41
	3	144 ,,	0·51	0·15	0·36
	3a	96 ,,	0·41	0·05	0·36
	4	144 ,,	0·55	0·23	0·22
	4a	144 ,,	0·78	0·34	0·44
	5	72 ,,	0·52	0·48	0·04
	5a	144 ,,	0·53	0·00	0·53
	6	144 ,,	0·50	0·19	0·31
	6a	144 ,,	0·51	0·24	0·27
	7	96 ,,	0·48	0·15	0·33
	7a	120 ,,	0·61	0·20	0·41
	8	72 ,,	0·51	0·00	0·51
	8a	144 ,,	0·68	0·27	0·41
	9	120 ,,	0·59	0·22	0·37
	9a	96 ,,	0·52	0·16	0·36
Unsmoked sheet.	10	288 ,,	1·05	0·16	0·89
	11	288 ,,	1·40	0·11	1·29
	12	288 ,,	1·08	0·35	0·73
Crepe.	13	216 ,,	0·36	0·02	0·34
	14	264 ,,	0·24	0·00	0·24

REMARKS ON RESULTS.

The average figures obtained for the total volatile content of the 18 smoked sheet samples was 0·53 per cent. which is in agreement with that found by the previous determinations.

The average figure for surface moisture or volatile matter was 0·35 per cent. on the smoked sheet.

The average figure for Internal moisture or volatile matter was 0·18 per cent. on the smoked sheet samples.

The total loss on desiccation is greater for unsmoked sheet than for either crepe or smoked sheet but even when the total volatile matter amounts to 1·40 per cent. it is found that 92 per cent. of the amount is on the surface.

In dry crepe which is immediately to be mixed with sulphur preparatory to vulcanization the surface moisture may be as high as 0·34 per cent. and the average figure for smoked sheet was only 0·01 per cent. above this.

[1] In this connection attention is called to the very interesting figures published by O. de Vries Arch. 2 (1918). 852 on the variation in moisture

content of crepe and smoked sheet during the dry and wet monsoons. Dr. Vries gives 0.34 per cent. to 1·0 per cent. for the normal limits of moisture in crepe and 0·43 per cent. to 1·70 per cent. for the normal limits of moisture in smoked sheet.

The work of Miss Krayenhoff Van der Leur Comm. Delft II page 41 has also shown how considerable are the variations of moisture in raw rubber due to variations in atmospheric humidity. G. S. Whitby—J. S. Ch. I. (1918) 280 T.—has also shown that owing to the absorptive nature of the rubber surface, moisture may be retained to the extent of 1·4 per cent.

CONCLUSIONS.

The conclusions to be drawn from the above may therefore be summarized as follows:—

1. All smoked sheet contains moisture. This may amount to 1·0 per cent. without being abnormal, and on the average is about 0·5 per cent.

2. Of the total moisture in smoked sheet the greater proportion i.e., about 70 per cent.—is held as surface moisture. This is apparently held in an absorbed state and consequently is subject to variation. The variation is dependent on the atmospheric humidity and on the amount of serum solids left in the finished sheet (*See* page 606 "Estate Rubber" by Dr. O. de Vries also remarks of van Heurn Archief IV. 1921).

3. The examination of the samples submitted did not demonstrate that there was any significant difference in total moisture between those samples with opaque inner sections and those samples without opaque inner sections.

4. The opacity was not a characteristic of high internal moisture, for it was found that the average internal moisture content for the opaque sheets 1a, 2a, 3a and 4a, etc., was 0·18 per cent. and the average internal moisture content for the non-opaque sheets 1, 2, 3 and 4, etc., was also 0·18 per cent.

LIABILITY OF SMOKED SHEET TO DEVELOPMENT OF MOULDS.

With regard to the second portion of the investigation, namely to determine the effects of the moisture content in smoked sheet it was thought to be sufficient for the present to examine the samples from above to see if there was any noticeable difference in their propensity to mould development, and if so, whether such was related to their internal moisture.

Portions of the fresh samples were suspended in the air so that the conditions were the same throughout and they were examined daily to see which sample showed the first appearance of mould. The following table gives the samples arranged in order of internal moisture and in order of mould development and also in order of depth of opacity of internal section as judged by a rubber technologist.

Order of total Moisture.	Order of internal moisture.	Order of mould development.	Order of opacity
4a	5	4a	9a
2a	4a	2a	5a
8a	2a	8a	5
7a	8a	5	6a
9	6a	3a	4
4	4	4	7a
5a	9	8	9
9a	7a	7	8a
5	6	7a	2a
6a	9	—	3a
6	1	—	4a
3	7	Remainder not mouldy.	Remainder not apparently opaque.
8	3		
7	3a		
2	2		
1a	1a		
1	5a		
3a	8		

There does appear to be some relation between internal moisture and order of mould development but the relation is not very marked and as the same order persisted on the samples after they had been completely dried, and again allowed to develop mould it would appear to be probable that the substances in the rubber which promote mould growth serve to increase the moisture content and it is not the moisture of the rubber which gives rise to mould.

It may be noted here that another investigation is being conducted on the nitrogen content of the samples in order to settle this point, so far, however, no definite results are available.

VULCANIZING CAPACITY.

With regard to the vulcanizing properties of the samples of smoked sheet and the tensible properties of the vulcanized products the results showed that the amount of moisture contained even in the wettest samples had no apparent effect.

The differences in total moisture between the wettest and the driest samples did not persist when the samples were broken down during the sulphur mixing, and the internal moisture in all the samples of smoked sheet examined was apparently a negligible factor.

It will be of interest to determine to what extent moisture in crude rubber may be lost during working on the mixing rolls. No definite figures are yet available for publication, but the preliminary work in this direction has shown that while being masticated and mixed preparatory to vulcanization moist rubber can be deprived of considerable quantities of water without the necessity of enduring abnormal heating or rolling and it appears that even the total moisture in the most "undercured" samples of smoked sheet now sold on the market cannot persist after mastication and consequently will have no detrimental effects on vulcanizing properties of the rubber.—Agric. Bull, of F.M.S., Vol. IX, No. 2.

INSTITUTE FOR RUBBER RESEARCH, MALAYA.

The Colonial Office advised on October 18, that consideration has been given to the Association's views on the recommendations of the Formative Committee, and that Mr. Churchill consulted the High Commissioner by telegraph as to whether the imposition of the special export duty, amounting to ·021 of 1*d*. per lb. of rubber is feasible at the present low price of that commodity, and a reply was received that the Formative Committee, by a large majority, voted against the postponement of the scheme ; the High Commissioner adds that this decision was reached owing to their conviction that the rubber industry would be benefited by the Institute. In these circumstances, Mr. Churchill has instructed the High Commissioner to proceed with the necessary legislation for the Incorporation of the Institute, on the understanding that all the States of the Malay Peninsula, as well as the colony, are prepared to share in the scheme, and he proposes to reserve for further consideration in the light of the development of the Institute, the question as to its co-operation with similar bodies elsewhere in British territory.—Bull. of Rubber Growers' Association, Vol. 3, No. 11.

TEA.

GRAFTING OF TEA.

A. C. TUTEIN-NOLTHENIUS.

The following notes, taken from Bulletin No. LXXVI. of the Experiment Station for Tea, Java, may be of interest to the readers of the Tropical Agriculturist :—

During the middle of 1919, several experiments with the grafting or budding of tea were made on the estates owned by the Rubber Plantations Investment Trust Ltd. (Sumatra), and although it is too early to say what results will be obtained in years to come, grafting of tea has been proved to be possible of meeting with success. A good method giving over 80% of successful grafting has been discovered.

WHY SHOULD TEA BE GRAFTED?

Although we have read and heard quite a lot about the budding and grafting of rubber, we fear that most planters will be very sceptical when reading these short notes on the budding of tea, but it must not be forgotten, that very little really is yet known as regards ennobling tea, improving yat increasing yields, etc., and that continual earnest experimenting alone may bring our knowledge of the bush more into line with other agricultural undertakings. We plant, pluck, prune and manure but too little interest is shown in the scientific side of our main industry.

1. The main object in view when the experiments with grafting and budding of tea were started, was to get a garden of even, good tea-seed bearers, giving the biggest yield of the best seed per acre. In a plot of tea-seed bearers it will be found that a certain percentage are good yielders, while others remain poor or do not yield and are unsuccessful for several reasons.

To cut these out would be an easy and good method but it would prove expensive having a small number of good trees on too big an acreage. The poor yielders can be replaced by young plants or by replanting trees known for their good quality of leaf, etc. This method proves disappointing as a certain percentage of the supplies again would be unsuccessful while the time taken for these supplies to come into bearing would be too long, the crop being late as well as irregular.

The best way to replace poor yielders would be by propagation, obtaining offspring from good trees known for their yield and seed quality.

2. Well known good yielders in not-isolated plots or in unfavourable circumstances are too old for transplanting in isolated plots.

3. For certain reasons one may desire to increase the number of a special tree. For instance, bushes have been found to survive and flourish well in fields practically killed by root diseases, (rosalinia, etc.) If this proves these bushes to be fungus-resisting, it would be very important to experiment with tea-seed bearers obtained from such bushes.

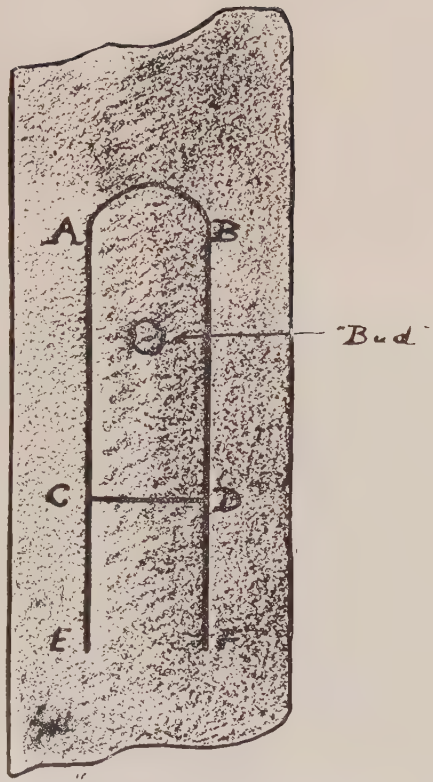


Fig. 1.

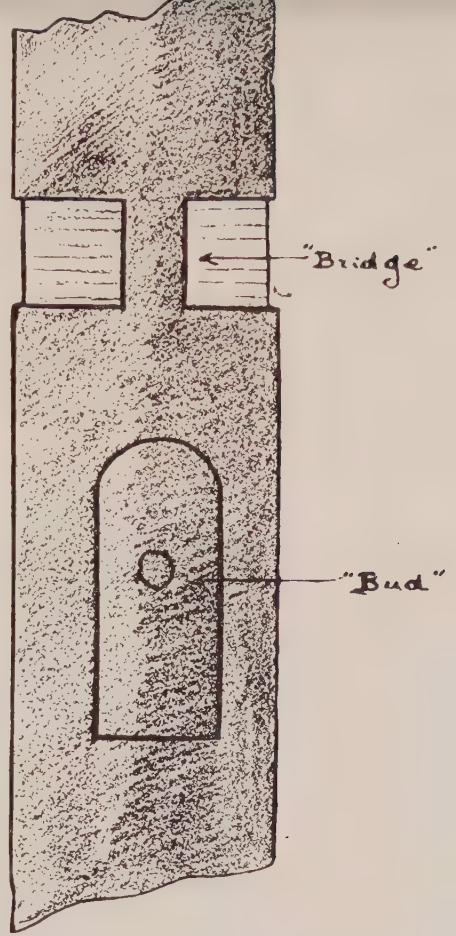
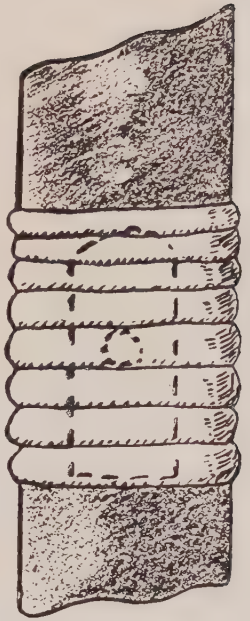


Fig. 2.



Bandaged Graft

Fig. 4. Budded tea, showing buds beginning to shoot.

Fig. 5. Same bush of tea, eight-months later.
Reproduced from Bulletin 76 by J. G. J. A. Mass, Tea Experiment Station, Java.

4. To obtain several offspring from the same bush or tree for experimental purposes. (Propagating good type, etc.)

5. To try and improve poor bushes or poor jat in fields already in bearing by grafting or budding, not by replanting as is the case now.

It is interesting to note that experiments taken with sending branches with buds, pieces of bark with buds, and scions, etc., by post, have proved successful, e.g., it will be possible to obtain buds and scions from well-known "mother" trees from other tea-gardens or countries.

METHOD OF BUDDING TEA.

Although crown-, cleft-, and side-grafting of tea have met with a certain amount of success, the best and most easy method for inexperienced workmen (coolies) has been found to be the ordinary bud-grafting or "budding."

I. Small rectangular pieces of bark, about 1½ in. x 2 in., containing a healthy bud are cut carefully from the thick branches of the "mother" tree, and as soon as possible, inserted in wounds of the same size, made on the 1½ in. to 3 in. thick branches of the poor tree to be grafted.

The most easy way is :—(see fig. No. 1) cut with a sharp knife the half-circle A-B. Carefully lift the bark with the bone end of the grafting knife, and strip loose to E-F., then cut C-D, care being taken not to injure the cambium or in any way defile the small piece of bark or the to-be patched wound.

There is no necessity to cut off any branches. This means the "mother" tree is not damaged, the wounds healing very quickly.

The small shield of bark with bud having been placed in position, the whole is then carefully bound with waxed tape or paraffined cotton "puttee" fashion.

II. 3 weeks later the bandage can be removed and the grafting examined if the small patch of bark is still green. This being found the case, the branch can be "ringed" just above the bud, a small "bridge" of bark being left. (Fig. No. 2.) The bandage is replaced, care being taken to leave the bud uncovered.

III. If after one month the bud is found to show signs of "sprouting,' the entire branch just above the grafting can be cut or sawn off, the cut being tarred or covered with a mixture of yellow wax and kerosene oil.* If the bud is still dormant the cutting off of the branch can be delayed another 2 or 3 weeks.

The above short resumé gives the method employed with success for the budding of tea, 80% successes having been reported as being obtained by ordinary estate coolies after some little practice.

Budding and grafting in general is most successful when the trees are in good vigour and in full growth, and it is thought that the months of April-May, for those areas which receive the April-May showers, and September-October for those which receive only the North-east monsoon, would be most suitable.

It will be interesting to watch experiments and results proposed to be carried out at Hakgala during the present year.

---

* Mixture—2 lb. yellow wax or paraffin to one bottle kerosene oil,

COFFEE.

FUNGOID DISEASES OF COFFEE IN KENYA COLONY.

CAPT. J. McDONALD, B.Sc.,

Mycologist, Department of Agriculture.

General Consideration.—In dealing with fungoid diseases we are concerned with a struggle for supremacy between two plants, the fungus and its host, which is, in this case coffee.

There are very many differences between a fungus and an ordinary plant as commonly understood, but there is one in particular to which the scientist attaches prime importance. The difference is that the fungus does not possess chlorophyll, the green colouring matter, of ordinary plants. If as is often the case, the fungus is one which obtains its food exclusively from dead organic remains, it usually causes no trouble. There are, however, a large number which obtain their nourishment from living plants and it is these with which the planter has to deal.

Successful attack on the part of the parasite depends on several conditions. Generally speaking, warmth and moisture are its chief requisites for development. Without the latter the spores of the fungus, which roughly correspond to the seeds of higher plants, cannot germinate and therefore infection by this means cannot be initiated. Given, however, favourable climatic conditions, the success of the attack still depends largely on the health and vigour of the host. It is therefore of great importance to ensure that conditions favour the tree. Planting in an unfavourable soil will handicap a tree from the start. Weeds by absorbing nourishment from the soil, interfering with aeration, etc., are conducive to unhealthiness, and bad planting and overbearing are further factors producing weakness.

In Kenya at present there are only two diseases of importance which come under the heading of this bulletin. These are the Leaf Disease and Die-back. Even then, it is doubtful whether fungi are ever the primary cause of the latter. Several other diseases give varying degrees of trouble, usually slight or insignificant. Some account of all at present known to occur, however, is included in the following pages in the hope that settlers may be able to identify diseases occurring in their shambas or,in the event of a new disease appearing, may be led to report its appearance at once.

Rust or Leaf Disease (*Hemileia vastatrix*).—This is the most serious fungoid disease of coffee found in this country. If allowed to go unchecked it is capable of defoliating a plantation, while any considerable attack represents a loss of a proportion of food which the leaves would normally manufacture and which should be employed in the further development of the bushes and in the formation of the coffee bean.

In Ceylon during the latter part of the last century, the ravages of Leaf Disease caused the abandonment of the coffee planting industry. While it

is not thought likely, with our better knowledge of the disease and under the different conditions prevailing in this country, that the disease would cause such havoc here. It still behoves coffee growers to regard it with respect and to keep a watchful eye for its appearance.

The disease is usually first detected by the appearance of orange-yellow spots on the lower sides of the leaves. These spots which are very small when first visible, may enlarge to about half an inch in diameter. The orange-yellow powder of the spots consists of a vast number of the spores of the fungus, each of which is capable when mature of causing a fresh infection. No spores are produced on the upper surfaces of the leaves but when the spots below have become fairly large, pale areas are noticeable above corresponding with the spots below. The centres of the latter as they get older become brown or grey. A severe attack on a leaf may cause it to dry and turn brown.

Infection is produced by the germination of a spore on the under side of the leaf. The spore sends out a fine tube which gains access to the interior of the leaf through one of the numerours breathing pores. Once inside, the tube grows between the cells and forms numerous branches, the whole fungus body being known as the mycelium. This mycelium develops smokers which it intrudes into the cells for the purpose of absorbing the cell content. After a time a part of the mycelium masses in one of the air-spaces beneath a breathing pore and sends out short pedicels through the pore. From the ends of these pedicels the spores are formed. These are at first colourless, but on maturing, the contents of each spore becomes orange-yellow, thus producing the characteristic colour of the spots.

While it is true that the best kept shambas are sometimes invaded by the Leaf Disease, severe attacks in this country are commonly found to be connected with neglect. Weeds are a great source of danger. Not only do they impoverish the ground to a certain extent but they harbour spores of the fungus and, in bad cases, interfere with the ventilation between the bushes and tend to create a damp atmosphere favourable to the activities of the fungus.

A proper system of pruning should be carried out to promote a healthy growth of the bushes.

Diseased leaves should not be left lying about between the bushes. *Hemileia vastatrix* is known to continue spore production on affected leaves for some days after the leaves have fallen. The leaves should be dug under or burned, preferably the former, as by this method organic material is returned to the soil.

It is a matter of common observation that the first leaves of a bush to be attacked are frequently those which are allowed to hang down close to the ground. Fallen spores splashed up by rain easily reach such branches, which should, therefore, be cut off.

Spraying trials in this country have shown that certain fungicides may be used with success as preventive measures against Leaf Disease. Details of three such sprays are given in a pamphlet issued by the Department of Agriculture, entitled " Three Sprays for Coffee affected with *Hemileia Vastatrix* and other Fungous Diseases." Further spray trials are at present in progress and, should these prove successful, details of them will be published later.

Spraying undoubtedly entails a certain amount of trouble and expense not only in labour but also in the purchase of the necessary chemicals. It is not, therefore, suggested that the spraying the whole of a large shamba should be done every season. It is urged, however, that spraying done at certain times is highly beneficial and well repays trouble and expense. For example, in localities where conditions are favourable to the fungus (such as in the lower parts of the Highlands in a wet season), where signs of the disease have been noticed during the previous season or where the bushes are known to have been weakened from any cause, spraying should be carried out.

In spraying against Leaf Disease it is important to ensure that the under sides of the leaves are thoroughly wetted. The finest nozzle obtainable should be used.

A good plan is to spray once shortly before the rains usually commence and again when the young leaves have expanded somewhat. If second spraying is neglected, the area of new surface exposed by the development of the new leaves will be unprotected by the fungicide.

It has been found in other parts of the world that heavy applications of farmyard manure (½ cwt. per tree) have been successful in controlling the disease.

There are leaf diseases known to occur in the Colony but none of them has proved serious.

Brown Eye Spot (*Cercospora coffeicola.*)—This is the commonest of these lesser leaf spots and is also found on the coffee berries. On the leaves the disease produces round spots usually about a quarter of an inch in diameter. At first these spots are brown but later the centres become greyish white with reddish-brown margin. Affected berries turn black and shrivel, while the pulp tends to adhere to the bean.

The fructifications are found in the centres of the spots and on both sides of the leaf. The spores are colourless, long and tapering.

Brown Blight (*Cloesporium Coffeanum*).—This fungus may produce infection on leaves, berries or twigs but up to the present damage as the result of its attacks has been insignificant.

The leaf spots are, as a rule, much less regular in outline than those caused by Cercospora. They are first brown, then grey, up to an inch in diameter, while those occurring on the margin of the leaf are frequently elongated. The points where spores are being produced may be seen as minute black specks in the spots, usually on the upper surface of the leaf.

When the berries are attacked a dark stain, which lowers their value, is produced on the beans.

Should either of these diseases become sufficiently serious to call for special measures, spraying with either Bordeaux or the Carbide mixture as described in the pamphlet cited above, is recommended.

Leaf Spot (*Mycosphaerella coffeicola.*)—Isolated cases of this disease have occurred in this Colony but, as in India, the damage done seems trifling. Small white spots surrounded by a dark band which gradually merges into the normal leaf colour are symptoms. Here again minute black points mark the location of the spores.

Sooty-Mould (*Capnodium Brazilienſe*).—This is a fungus which occurs chiefly on young coffee, giving the plants the appearance of being covered in soot. This condition scarcely comes under the heading of a fungus disease as the fungus derives no nourishment from the coffee bush but lives on the honeydew excreted by various kinds of insects. It is, therefore, an indication of insect attack. The only harm done by the fungus itself lies in its interference with the free passage of air and sunlight to the leaves.

The remedy for the trouble consists in getting rid of the insects and this varies according to the particular species involved.

Die-back—Die-back is a very common malady in this country and is characterised by a blackening and drying up of the primary branches. A few branches may be affected here and there or, as is commonly the case, the whole middle portion of the bush may show the disease while a few shoots at the crown and at the base may remain green.

There is no single cause to which all cases of Die-back can be attributed. Sometimes one or two species of fungi *(Phoma, Colletotrichum,* etc*).* are found associated with the disease but it is doubtful whether, in this country, a fungus is ever the prime factor.

Probably the most fruitful cause of Die-back is over-cropping followed by an abnormally dry period. Even in a normal season, young plants (2-3 years old), carrying a heavy crop where no disbudding is carried out may die back considerably. Dry weather conditions may also contribute to the trouble by permitting a severe attack of Thrips.

A faulty root system, due to bad planting (twisted tap root, etc.) cut worm damage or the presence of a hard pan hindering root development, are further possible causes.

Trees weakened by a severe attack of Leaf Disease often succumb to Die-back and trees struck by lightning may show a similar appearance.

Root Diseases.—The usual symptoms exhibited by coffee bushes suffering from root diseases are a general unhealthy yellow appearance and wilting.

It is rarely possible to name the fungus responsible for the trouble as definite identification depends on an examination of the fructification of the fungus which is only very seldom met with. In the majority of cases root diseases can be traced to the presence of portions of decayed roots of forest trees left in the ground when the land was first cleared.

It is very difficult to save a bush once it has become infected and attention, therefore, would rather be directed to preventing the spread of the disease to neighbouring trees. To do this the affected bush should be dug up with as much of its roots as possible and the whole should be burned on the spot. Any portions of old stumps found in the soil should receive similar treatment. To prevent the fungus spreading through the soil a trench 18 inches deep should be dug round the tree and another should be dug to include the immediate neighbours of the diseased tree in case infection has already reached any of them. In digging the trench the earth should be thrown into the infected area and the soil of this area should be frequently turned to allow free access to sun and air.

It is unwise to replant in the affected spot for a period of 18 months. Some shade trees are known to be capable of starting root disease and their stumps should therefore not be allowed to remain in the ground when such trees are cut down.—Farmers' Journal, Vol. 4, No. 1.

THE MANURING OF COFFEE ESTATES.

"PLANTER."

In the very early days of Coffee planting the short-sighted policy was indulged in of letting estates go years without manure. Since manuring was taken in hand, planters in Mysore and Coorg have depended mainly on bones and poonac for manuring their estates. I cannot speak with any certainty of other districts; but that the practice was fairly general is evident from a letter published in the Press from Mr. John Kenny, late Manager of the Madras Presidency Manure Works, in which he says, "Bones and white castor have for years been employed by coffee planters in India as a complete manure." The practice is continued till this day in some cases. A certain amount of farmyard manure (cattle manure and sweepings of cooly lines) is utilised, but the quantity available is not sufficient to apply to more than a portion of the area manured each season, except in a few cases. The acreage manured every year usually varies from one-fourth to one-third of the area. In rare cases half the area of an estate, and in still fewer instances the whole of a place is manured every season.

Cattle are expensive to keep for manurial purposes alone, and a large number of estates do not possess the grazing land necessary. At one time in South Coorg dry cattle droppings and village farmyard manure was largely purchased; but it proved expensive, and the results were probably not deemed commensurate with the expenditure, for the practice was discontinued. All planters agreed that cattle manure is *par excellence* the best fertiliser for coffee. Possibilities exist for agumenting farmyard manure by making composts of vegetable matter, cattle manure, lime, line sweepings, coffee pulps and soil. Though this is not neglected in some cases, it is not generally carried out to the extent that it might be. Want of labour is a handicap in some places, bulk manure being slow of application, as to obtain the best results it is necessary to apply half a bushel to each tree. Too often half that quantity is applied to a tree: and I have known cattle manure to be applied at the rate of half a bushel to three trees. This is obviously only sufficient for one season. Jungle top soil and swamp soil are sometimes applied direct to the coffee. The former is of the best, but would be all the better for lime being mixed with it, perhaps at the rate of one of lime to ten of soil. But it is difficult to get good jungle top soil unless there should be a reserved piece of jungle which it is not intended to open. Ryots in South Coorg at one time sold soil to the estates, but Government stopped this impoverishment of their land. It is more necessary to mix lime with swamp soil, especially if it consists of clay, in order to reduce its elements to a soluble state. Liebig says: "The process by which the elements of clay are brought into a soluble state by fire corresponds to that by which they are brought into the same condition by the action of lime." The weathering action of the atmosphere will act more slowly and the results will not be as thorough and satisfactory as those brought about by the action of lime, and, in the meantime, the presence of the clay, as clay, may be deleterious to the trees.

Fish and "fish guano" are sometimes applied to the coffee direct or are added to a compost, rendering it very rich in all constituents, chiefly

nitrogen—but the all-important element of potash is wanting. Fish guano consists of what is left of the fish after the extraction of the oil. Fish manure may be said to be bones and poonac (oilcake) in another form, for it contains exactly the same plant foods—nitrogen and phosphates ; the organic part of the fish supplying the former and its bony structure the latter. Applied alone, it is apt to supply an excess of nitrogen to the soil, being practically a nitrogenous manure, as the organic part more readily decomposes and becomes available than do the phosphates. The same happens when bones and poonac are applied. The bone meal is said to persist in the soil for two years, by which time the poonac is all exhausted. Burnt clay has also been applied at times. Applied in sufficient quantity it improves the mechanical condition of the soil, making it more open and friable ; but it has hardly ever been produced to the extent of being useful in this respect. It is also useful for mixing with artificial manures to secure the more equable distribution of the latter. Finally leguminous green crops have been grown where the coffee has not been too dense to permit of their successful growth and incorporated with the soil, and that other form of green manuring of growing *Erythrina lithosperma* in the coffee and mulching the soil with its loppings is carried out on some places.

Most of the methods of manuring here enumerated have been the result of innovations gradually introduced, and some of them are the direct result of the Scientific Officer (the Deputy Director of Agriculture) Mr. Anstead's advice. When manuring was first taken in hand, half inch and one inch bones were largely applied in small holes near the collar of the trees. In eradicating borer these bones were turned up even to the present day in compact masses cemented together by soil. The late Mr. Pringle, Agricultural Chemist to Messrs. Matheson & Co.'s estates in South Coorg, might well have characterised this as "manuring for posterity." It is appalling to contemplate the amount of money that must have been wasted under the mistaken notion that this method of applying bones was the most approved way of supplying the needs of the trees of plant food.

In all the methods of manuring here noticed, it is to be noted that the plant foods chiefly supplied are nitrogen and phosphates, and in nearly all of them, with the one exception of farmyard manure, the nitrogen is in excess. Farmyard manure is a complete general manure and contains an appreciable amount of potash, which important plant ingredient is notably absent in all the other manures noted. Mr. J. Hughes, the Agricultural Chemist, who came out to report on Ceylon soils and the manures best suited to them when coffee was still extant there, gave it as his opinion that excess of nitrogen was not necessary to the well-being of coffee ; and the late Mr. Pringle pointed out that an excess of the substance acted deleteriously in making the trees grow a profusion of wood and foliage to the detriment of crop. This has received corroboration from Mr. Anstead, who agreed with Mr. Pringle that the show of blossom was often out of all proportion to the crop harvested, and the reason for this was probably to be found in an excess of nitrogen supplied to the trees.

Mr. John Kenny in his letter to the Press referred to above, says ; "It is difficult to understand the absence of potash in the mixtures used on coffee plantations," especially as, I may add, in all analyses of coffee soils

only traces of potash are shown as existing in them ; and that it is the most important element in the nutrition of coffee is clear from an analysis of the requirements of a yield of 7 cwt., by Mr. John Hughes. referred to above, which showed that the quantity of potash extracted from the soil was nearly double that of the phosphates and more than double that of the nitrogen. Dr. Voelcher the eminent Agricultural Chemist, in his analysis of the coffee and tea soils of Southern India showed that they being of laterite formation, were particularly deficient in phosphoric acid and lime. Lime is another constituent that has not been used as largely as it might have been with the greatest possible benefit. Dr. Voelcher, Messrs. Anstead and Cameron have recommended the application of tons per acre. At one time apprehensions were entertained that lime burnt up everything in the soil, perhaps because heat is produced when it is slaked, and destroyed its fertility ! It would take up too much space to enter upon a discussion of the functions of lime in soil, but it may be pointed out that it is an indispensable ingredient of all fertile soils and that in Coffee, where there is an excess of vegetable matter supplied by heavy mulchings from shade trees and weeds, and green manure, its application is necessary to bring about its more complete decomposition.

During the War potash was unobtainable owing to the only known source of supply, Germany, being cut off. But Dr. Lehmann, late Agricultural Officer to the Mysore Government, showed by an analysis that lantana ashes contain as much as 13 per cent. of this valuable constituent. It is not necessary to cut lantana before burning it, as there is an accumulation of dry branches under the thickest in the dry season sufficient to raise a conflagration great enough to consume nearly all of them except the roots. I have had opportunities of seeing this tested again and again. And yet this cheap source of potash is not utilised to the extent it might be. I have seen acres of lantana ashes in the vicinity of an estate lying neglected on the score of its being too expensive to merely transport and apply them to the Coffee. It is to be noted that in all cases where a complete manure is used the result in crops is more satisfactory, and it may safely be said that the addition of an adequate percentage of potash to manure mixture is more highly appreciated now-a-days and is coming into more general use.

Coffee invariably responds magnificently to liberal treatment. The case of Mr. Mangles' Cover-Kollie estate may be cited in illustration of this. According to the late Mr. R. H. Elliot, the well-known Mysore planter, every acre of this estate used to be manured every year on the following plan. Half the estate received cattle manure at the rate of half a bushel per tree, and the other half artificial manure, and the whole estate a small dose per tree of Nitrate of Soda. The succeeding season the half that received the cattle manure the previous season received artificial manure and the other half the cattle manure, while the whole estate was given the usual dose of Nitrate of Soda. Mr. Elliot said that the place was the best coffee property he had seen in Southern India (and he had visited a good many). It is 600 acres in extent, I believe, and under the treatment above outlined, it produced an average of 2001 tons of crop yearly.—Indian Scientific Agriculturist, Vol. 3, No. 1.

FOODSTUFFS.

AWARDS FOR PADDY TRANSPLANTING COMPETITIONS IN MATARA DISTRICT.

The Divisional Agricultural Officer in company with Mr. J. D. Brown (Assistant Government Agent, Matara), and Mr. E. Buultjens carried out the final judging of the transplanted paddy plots in Kandaboda, Wellaboda Pattus and the Four Gravets, Matara, on the 18th and 19th March. The awards were made as follows:—

Kandaboda Pattu.

D. A. Wickremasinghe	...	1st prize
I. Don Henderick	...	2nd ,,
D. A. A. Kodippily	...	3rd ,,

Wellaboda Pattu.

D. G. Don Davith	...	1st prize
C. Tillekeratne	...	2nd ,,
W. R. Deonis	...	3rd ,,

Four Gravets.

B. Alwis Appu	...	1st prize
Carolis Appu	...	2nd ,,
Davith Sinno	...	3rd ,,

The final judging for the prize offered by Mr. E. W. Goonatilaka for the best paddy plot in Weligam Korale was also carried during the month; the award being made to D. J. Yapa of Maragoda.

In both cases the awards were made on the following basis:—

Estimated yield ...	...	20 marks
Uniformity ...	...	20 ,,
Cleanness ...	...	20 ,,
Free from disease	...	10 ,,
Strength of straw...	...	10 ,,
System of irrigation	...	10 ,,
Distance between plants	...	10 ,,
		100 marks

PADDY TRANSPLANTING COMPETITIONS IN URUWALA PERUWA, HENARATGODA.

The following are the results of Uruwala Peruwa Paddy Transplanting Competitions during the last Maha season:—

Name of Winner	Address.	Prize.
E. A. Perera	... Vel Vidana, Kinigama	... 1st prize. English plough and a pair of buffalos offered by the Uruwala Peruwa Co-operative Credit Society.

Name of Winner.	Address.	Prize.
Don Carolis Eduru-suriya	Malwatuhiripitiya	... 2nd prize. Rs. 15, offered by the Department of Agriculture.
Don Charles Alwis Appuhamy	Uruwela	... 3rd prize. Rs. 10, offered by the Department of Agriculture.
Don D. Dissanayake	Police Vidane, Pitumal-goda	Special prize. Rs. 10.
Don Hendrick Gune-sekera	Police Vidane, Pasgam-mana	Certificate.

The following were recommended Certificates for good results of their transplanted plots which were less than an acre :—

D. S. Dinawaka, Vel Vidane, Pilikutuwa.
Don Charles, Vel Vidane, Buthpitiya.
Vel Vidana of Pasgammana.

Don D. Dissanayake, who had one of the best plots but less than one acre in extent, was recommended a special prize.

A. B., ATTYGALLE,
A. I. Veyangoda.

YAMS (DIOSCOREAS) IN KANDY DISTRICT.

W. MOLEGODE,

Agricultural Instructor, Central Division.

A good amount of yams (Dioscoreas) is cultivated in Kandy but not to the extent that may be expected. In Yatinuwara, Uda Palata and Udunuwara chiefly, and in Harispattu and Tumpane in a limited scale the following kinds are cultivated, viz., *Engili-ala ; Katulala ; Keku-lala ; Bindara-ala ; Kahata-ala*, *Rajawalli*, *Japanè-ala* ; and several other varieties going under the general name of Vel-ala. During the next few months specially, the cultivation of yams will be carried on as the last few months saw the lifting of the crop. Most varieties of *vel-ala* are seven months crop and are lifted after August. Although the crop is ready to be harvested in seven to nine months the lifting can be delayed for a few months more and sometimes yams are not lifted till the second year, when generally a much better crop is obtained. Uprooted yams do not keep long and are therefore lifted as required.

Planting.—Usually yams are planted during February to April though this is not the only time yams can be planted. The cultivation is easy and requires little attention. Holes 1½ ft. to 3 ft. depending on the variety to be grown are dug at a distance of 4 feet apart and filled up with loose soil. In these the yam heads or pieces of yams are planted and are provided with sticks to climb upon. After this very little attention is necessary beyond watering if the weather conditions be very dry and providing a cover of mulch of dry leaves or straw.

Seed yams.—Yams are propagated by tubers produced along the stems or by pieces of the mother yams taken from the upper and older part. The 'Yam Head' or the crown is always planted the following season. As a rule when yams have been lifted and taken for use the top part of it is cut off and stored away in a cool place. It will sprout in time for planting. The stem tubers (*Kondol*) of the first year are generally not used for propagation. Preferably only sprouted pieces are planted.

CEYLON AGRICULTURE.

DEPARTMENT OF AGRICULTURE, 1921.

EXPERIMENTS AND INVESTIGATIONS.

The following are the reports furnished by the Department of Agriculture for the 68th Annual Report of the Planters' Association of Ceylon :—

ESTATE PRODUCTS.

Experiments with tea, rubber, cacao and coffee continue to be carried out at the Peradeniya Experiment Station, with sisal, limes, coconuts and oil palms at the Anuradhapura Experiment Station, while trials of cotton have been begun at Ambalantota in the Southern Province. Manurial experiments with coconuts are also being carried out at Chilaw.

The depression in the rubber industry has resulted in a large number of enquiries being made regarding the prospects of other economic crops. Bulletins have been prepared on the cultivation of limes and of pine-apples. Several planters have planted up nurseries of limes preparatory to making an experimental trial with this crop, while enquiries are being made in regard to the prospects of pine-apple canning in the colony. The cultivation of Robusta types of coffee is also extending, particularly in the Ratnapura district. Investigations have also been made into the possibilities of sugar-cane cultivation for the production of power-alcohol and sugar. The cultivation of newly imported varieties of sugar-cane in the Southern Province has demonstrated that they are likely to yield much larger crops than the varieties formerly cultivated. The experiments being made by Government with cotton cultivation have again stimulated a certain amount of interest in this cultivation and there is no doubt that the local Spinning and Weaving Mills could absorb all the cotton that the Island could produce. Distillations of camphor grown at Peradeniya have been made, but the results have not been very satisfactory. Analyses seem to indicate that leaves and small stems of camphor grown up-country yield higher percentages of solid camphor than do leaves and stems from the Peradeniya area. Experiments have also been made with Chenapodium and with the distillation of oil from the local species and from others grown from seed imported from Java.

The possibilities of Gliricidia as a green manure for tea have been demonstrated at Peradeniya. Tractor trials were conducted by kind permission of the Directors on Clovis Estate, Kurunegala and the relative value of different types of tractors in coconut cultivations tested. Budding and grafting of rubber has received attention. Success was obtained in these experiments in September, and the methods employed have been demonstrated to the Estate Products Committee of the Board of Agriculture and to a meeting of the Kalutara Planters' Association.

The efficacy of the disinfection at Colombo of imported tea seed has been tested. The method has been found not to be reliable and in the

interests of the tea industry will be discontinued and the import of tea seed from India prohibited. Scale insects on tea in the Haputale district were investigated by the Entomologist and his report was published for general information. Red rust has been prominent in the Ratnapura district and was the subject of discussion before the Sabaragamuwa Planters' Association. The Shot-hole borer pest of tea has received close attention during the year. The latest reports indicate that the pest is at present greatly on the decrease. This in some instances is ascribed to the adoption of better cultivation methods, and to manuring, while it is possible that the year's climatic conditions may have been unfavourable to the pest. The regulations in regard to the control of the movement of tea plants and stumps were found to be unsatisfactory during the year and have been amended so as to conform with the latest investigations in regard to the occurrence and spread of the Shot-hole borer pest. Special work was done in the Badulla district on this pest during the year and is being continued. Tea termites have also been under close investigation during the year.

Diseases of rubber have been less common during the year. A discussion has taken place as to the advisability of adding Fomes, Poria and Ustilina diseases of rubber to the Pest Schedule, but the consensus of opinion was against this proposal. Diseases of coconuts have received the special attention of a Mycologist during the year. These investigations appear to indicate that physiological courses may account for a considerable amount of nut-fall and leaf-droop. The coconut pests of the Batticaloa district have been carefully investigated during the year and the coconut caterpillar added to the scheduled list of insect pests of coconuts which may be dealt with by Plant Pest Boards.

Diseases and pests of cacao have not been in particular evidence during the year, the dryness of the season resulting in smaller losses from pod disease.

The further reorganization of the Department of Agriculture has made progress during the year. Three Divisional Agricultural Officers have been established at Galle, Jaffna and Peradeniya, and an Inspector for Plant Pests and Diseases (Southern) has taken up Headquarters at Avisawella. Additions to the Mycological staff, which had been urged by the Planters' Association, could not be made owing to the urgent necessity for restricting expenditure.

The construction of the new Entomological Laboratory has been practically completed during the year and the building of the new Mycological Laboratory will be begun early in 1922. The Board of Agriculture has been legally constituted. It is advisory to the Department of Agriculture and to Government in all matters agricultural and its Estate Products Committee deals with all questions affecting planting products.

Detailed reports from the Mycological, Entomological and Central Inspecting Division for Pests and Diseases are appended.

REPORT OF THE MYCOLOGICAL DIVISION.

RUBBER.

Diseases of *Hevea* were less in evidence during the last year. The irregular rainfall during the South West Monsoon was unfavourable for the development of leaf-fall and pod disease, and though this disease occurred in some districts there was no general outbreak.

Root diseases of *Hevea* constituted rather more than half the total of *Hevea* specimens submitted for examination. Of these 42 per cent. were

Fomes lignosus. 41 per cent. Brown root disease, 11 per cent. *Ustilina*, and 3 per cent. Poria: Two cases of a root disease which is probably caused by a *Xylaria* were recorded: this disease was first noted in 1909, when one case was found, but it had not been observed since.

Complaints of "rust" on smoked sheet have been fairly common. In some instances, this was not the appearance which has hitherto been known as rust, but some new supposed defect discovered by the buyers referred to under the old name. The term rust has hitherto been applied to the formation of a superficial film which cracks when the rubber is stretched. It is now being applied to rubber on which no such film is present, but on which a mark can be made by scratching it. It is quite possible to make a mark with a rough instrument on rubber which is not rusty in the proper sense of the term. Whether that in some cases denotes a defect in the rubber due to chemical action or faults in preparation has not been determined, but it has not been possible to associate it with fungi or bacteria.

TEA.

Red rust, which has been prevalent in certain districts for the last two or three years was specially prominent in the Ratnapura district during 1921. A lecture on the subject was given to the Sabaragamuwa Planters' Association, and was published in the daily press. It is generally held that Red Rust is a disease which is serious only on weak bushes, and that among the causes of weakness of the bushes are poverty of the soil and over-plucking. The cessation of manuring during the period of the war, coupled in some cases with hard plucking at the same time, has probably been the main contributing factor to the present occurrence of the disease.

Several cases of the leaf disease of tea caused by *Cercosporella Theae* were recorded during the South-West Monsoon, nearly all from Up-country estates. In practically all cases this leaf disease begins on *Acacia* and spreads from the *Acacia* to the tea. The *Acacias* are defoliated, and the falling leaflets convey the disease to the neighbouring tea, in addition to the more normal distribution of the fungus by means of wind-borne spores. *Acacia decurrens* is the usual species concerned, but that is simply because it is the one most generally planted; the fungus can also attack *Acacia dealbata* and *A. melanoxylon*. Several instances have been recorded in which this disease has occurred in fire-wood reserves on *Acacia decurrens*, and has spread from that plant to Red Gum (*Eucalyptus robusta*) and Karri (*Eucalyptus diversicolor.*) The disease does not appear to originate on Red Gums and spread from them to tea. The occurrence of this disease invites consideration of the advisability of planting Acacias through tea.

COCONUTS.

The following notes on coconut diseases have been contributed by Mr. C. H. Gadd, Assistant Mycologist:

Coconut diseases in general have been less prevalent during the year owing to the drier climatic conditions being less favourable to fungus growth. No new disease has become prominent nor have any of the known diseases become more conspicuous during this period.

Nut-fall and leaf-droop still continue to attract attention in the Kurunegala district. Further observations on these diseases indicate that physiological causes may produce symptoms similar to those caused by the direct attack of the fungus *Phytophthora* sp. The removal, for any cause, of a leaf supporting a bunch of nuts is usually followed by a fall of these nuts owing to the nut branch (Spadix) breaking. The fallen nuts, if immature, rapidly blacken at the stalk and so resemble nuts attacked by *Phytophthora*. The drooping of the leaf is equivalent to its removal, and for this reason palms affected by leaf droop appear to be affected by nut-fall also. The exact conditions which lead to the physiological form of these diseases have not been accurately determined, but the disease has been reported from several places as following directly upon the drought of the earlier part of the year. The fall of nuts subsequent to drought has been long known but the drooping of leaves from this cause has not been recorded. It should be noted that an excess of water in the soil reacts upon the coconut palm in a way similar to drought. It is therefore, to be expected that deep draining in the wetter, low lying parts of the Kurunegala district will have a beneficial effect on these diseases.

A few cases of bud-rot have been investigated during the year. One case in the Negombo district demonstrated the very virulent nature of this disease under suitable conditions, amongst young palms. The necessity for the immediate destruction by fire of palms affected by this disease cannot be too strongly emphasised.

The removal and destruction of the parts of leaves affected by leaf-break disease or die-back has proved to be efficacious in keeping this disease in check

No organism has been found to be constantly associated with the 'taper stem' disease of coconuts. Examination of affected palms shows the stem and crown to be healthy though the leaves are dwarfed. In the absence of an active organism at the root, unsuitable soil conditions or malnutrition would appear to be the main causes of the disease. Where a palm is badly affected, only in rare cases would remedial treatment be worth while, for, if the treatment were effective there would always be a contrition in the stem where it had originally tapered, and with the palm again carrying a heavy crown the liability of the stem breaking at this point during a storm would be great.

REPORT OF THE ENTOMOLOGICAL DIVISION.

TEA.

The special investigations on Shot-hole borer were continued by the Assistant Entomologist during the year. Mr. Jepson's summary of his experiments is given herewith :—

"The Assistant Entomologist left Sarnia Estate, Badulla, early in April and returned to Peradeniya, but has kept in touch with the experiments still in progress on this estate by periodical visits.

During the year, attention in regard to this pest has been concentrated principally upon attempts to limit the incidence of borer by cultural methods, the disposal of prunings, and the experimental use of castor-oil plant as a trap-tree.

Several manurial experiments are in progress at Sarnia Estate with the object of ascertaining:—(1) whether any particular element, e.g., Nitrogen, Postash, or Phosphoric Acid, assists the bushes to withstand attack by borer; (2) whether borer attack is curtailed by manuring generally and (3) what part liberal manuring plays in promoting the process of gallery entrance healing The experiments are not concluded but it appears that Nitrogenous manures do, to a small extent, assist the bushes to withstand borer attack.

Castor trap-tree experiments are in progress in the Badulla, Balangoda, Hewaheta, Lower and Wattegama districts. The best grown plants in the Badulla experiment, which are now of ten months' growth, have already commenced to attract borer in large numbers. An experiment on a large scale near Kandy failed owing to the castor plants being completely destroyed by "rust" *Melampsorella Ricini*. Castor at an elevation of over 4,000 feet has been found heavily infected by *X. fornicatus* during the year.

An experiment on a large scale has been conducted to ascertain the effect of certain manures and insecticides upon the inmates of the galleries when buried with prunings, but the results are not yet available. Kerisol and Agrisol were the most successful substances tried, but their general use may be prohibitive on account of their high cost.

Observation regarding the habits of *X. fornicatus* in buried prunings have also been made. Development is able to proceed, without interruption, beneath the soil for a considerable period, all stages of the borer having been found in daily examinations of prunings up to nine weeks after burying.

A circular has been sent, at the instance of the Board of Agriculture, to every estate infested by borer, with the object of ascertaining the general, opinion regarding the present status of this pest. Judging by the replies so far received, it appears that borer is less prevalent than formerly, except in the Badulla, Haputale and Knuckles districts where it is considered to be on the increase."

The tea tortrix (*Homona coffearia*) is still prevalent at certain seasons in the districts where it has become established, and this pest appears to be extending its area of attack in parts of the Kelani Valley. No definite results have been obtained in the experiments made by the Plant Pest Inspector with the use of powdered lime against tortrix larvæ.

The fringed nettle-grub (*Natada nararia*) has again been prevalent during the year on several estates, mainly in Uva. This pest has become well established in the Uva tea districts and the prolonged droughts of 1920 and 1921 have been favourable for its almost uninterrupted breeding. This nettle-grub is now known to feed on a number of plants other than tea, most of these, it is true, are such as are to be found in bungalow gardens and are only slightly attacked. It was observed by the writer, however, that interplanted dadaps (*Erythrina*) were being readily eaten by caterpillars.

A sudden and unusually large outbreak of one of the so-called "bagworms" was reported from one estate, but this attack was checked in its early stages by systematic collection and destruction of the cases.

The importance of controlling all outbreak of leaf-eating caterpillars as soon as they are first noticed cannot be too strongly emphasized. The prompt use of a non-arsenical spray, such as lead chromate, on the few tea bushes to be attacked first will often serve to prevent a serious plague of caterpillars.

Tea termites (Calotermes sp.) have been reported from several estates during the year, and in some cases the attack was only detected after the tea bushes had been tunnelled right down to the roots and were in a dying condition.

Much of the external injury to tea bushes is caused by other kinds of termites which feed on dead wood. These termites contrive to cover portions of tea bushes with a film of earth, under cover of which they eat away any dead bark and wood resulting from old "branch canker" wounds or other injury.

Experiments are being made with certain wood-preserving liquids against these termites.

Large areas of tea on some up-country estates have been attacked by the scale insects known as brown bug (*Suissetis hemispherica*) and green bug (*Coccus viridis*). A report on a typical outbreak of these pests appeared in the Tropical Agriculturist for June, 1921, (Vol. LVI, No. 6, pp. 378-380).

Tea mites appear to have fairly generally prevalent during the year. Suggestions for the control of these pests were outlined in the Tropical Agriculturist for October 1920, (Vol. LV, No. 4, pp. 225-226).

RUBBER.

Several reports of rubber trees being attacked by a large boring grub have been received during the year. Specimens taken from the injured trees show that the damage has been caused by the Hevea stem and root borer (*Batocera rubus*). An account of this pest was given by Green in Bulletin No. 3 of the Department of Agriculture, and it has been mentioned in past Planters' Association insect notes.

COCONUTS.

During the year the writer has had opportunities of studying the three most important insect pests of coconuts, namely, the coconut caterpillar (*Nephantis serinopa*), the Rhinoceros or Black Beetle (*Oryctes rhinoceros*), and the Red Weevil (*Rhynchophorus ferrugineus*).

The caterpillar has been established in the Eastern Province for many years and during the last few years its outbreaks have been frequent. This year the local Plant Pest Board requested that the caterpillar should be declared a pest under the Ordinance and this has recently been done by His Excellency the Governor in Executive Council.

It has been found that the most effective method of controlling this pest is by the use of various kinds of lights to attract the moth stage, and these measures have been scheduled under the Ordinance. Plant Pest Boards will now be in a position to enforce these measures within their own districts whenever they consider it necessary. Outbreaks of the caterpillar have also occurred in parts of the Southern and North-Western Provinces during the year.

The two beetles are always present on poorly kept coconut estates where they breed in damaged palms, in old stumps and logs and in any mass of

decaying vegetable matter in far greater numbers than is generally realised. Between them they not infrequently kill out young palms and cause serious injury to older palms.

It is about time that a systematic campaign against these beetles should be started throughout all the coconut areas in the Island. The Eastern Province has already started its campaign.

REPORT OF PLANT PEST AND DISEASE INSPECTOR, CENTRAL.

The survey of the insect pests of tea estates in the Central Province has been continued, the inspection of twenty-three planting districts having been completed during the year and the inspection of the remaining district of Dimbula has been commenced, 31 estates having already been inspected. The inspection has covered 262 estates and 824 gardens, most of the latter being situated within the Kadugannawa-Gampola-Peradeniya triangle. Eleven nurseries have also been inspected.

121 estates and 820 gardens have been scheduled as being infested by Shot-hole borer *Xyleborus fornicatus* and 11 estates by Fluted scale *Icerya purchasi* during 1921.

PESTS.

The chief insect pests recorded by the Inspector and Sub-inspectors of this Division during the period under review are the following:—

Tea.—Shot-hole borer (*Xyleborus fornicatus*), Leaf miner (*Oscinis theae*), Tea aphis (*Ceylonia theaecola*), Brown bug (*Saissetia hemispherica*), White leaf louse *Chionaspis theae*), Termites chiefly (*Calotermes militaris*), Tea tortrix (*Homona coffearia*), Leaf roller (*Gracilaria theivora*), Red borer (*Zeuzera coffeae*), Fringed nettle grub (*Natada narraria*), Lobster caterpillar (*Stauropus alternus*), Small bag worm (*Psyche albipes*), Red slug (*Heterusia cingala*), Red spider (*Tetranychus bioculatus*).

Erythrina lithosperma (Dadap), Dadap caterpillar *Taragama dorsalis* Spotted locust, *Aularches miliaris*, Dadap stem borer, *Terastia meticulosalis*.

Acacia spp.—Fluted scale (*Icerya purchasi*).

Eucalyptus robusta (Cum), Tea tortrix, (*H. coffearia*).

Albizzia spp. Tea tortrix. (*H. coffearia*).

Cedrela toona (Toona) Toona shoot borer *Hypsipyla robusta*.

Miscellaneous.—Cardamoms, *Dichocrocis punctiferalis*, Common garden plants, Kalutara snail *Achatina fulica*. This mollusc has now appeared in the Badulla district.

PERMITS FOR SALE OF STUMPS.

108 applications have been received for permits to sell tea plants. Of these 90 were granted and 18 refused. A total number of 2,562,050 plants were sold on permit during the year.

PEST REGULATIONS.

The Shot-hole borer regulations have undergone revision during the year and in future permits may be granted for the removal of nursery stock from estates scheduled as being infested by *X. fornicatus* providing that they do not, in transit, enter the areas known to be free from borer.

MINUTES OF MEETING OF ESTATE PRODUCTS COMMITTEE.

Minutes of the 7th meeting of the Estate Products Committee of the Board of Agriculture held at the Experiment Station, Peradeniya, at 2-30 p. m. on Thursday February 9th, 1922.

Present.—The Director of Agriculture (CHAIRMAN), The Government Agricultural Chemist, The Assistant Botanist and Mycologist, Messrs. H. D. Garrick, E. W. Keith, N. G. Campbell, George Brown, J. S. Patterson, John Horsfall, G. B. Foote, R. Garnier, Graham Pandittasekera, A. S. Long Price, Gate Mudaliyar A. E. Rajapakse, Lt.-Col. T. Y. Wright, Major J. W. Oldfield, O.B.E., M.C.; The Hon'ble Mr. O. C. Tillekeratne and Mr. T. H. Holland, M.C. (Secretary).

As visitors, Messrs. N. K. Jardine, C. H. Gadd, Dennis Wood and T. B. Ranaraja.

Letters and telegrams regretting inability to attend were received from the Hon'ble Mr. B. Horsburgh, the Hon'ble Mr. H. L. De Mel, Sir Solomon Dias Bandaranaike, Messrs. C. P. de Silva, M. L. Wilkins, F. R. Senanayake, A. W. Beven, T. A. de Mel, J. B. Coles, W. R. Matthew, Dr. C. A. Hewavitarne, Hon'ble Mr. James Peiris, Hon'ble Mr. J. Graeme Sinclair and the Government Agent, Central Province.

The minutes of the previous meeting having been circulated to members were taken as read and confirmed.

Before proceeding with the business on the Agenda the Chairman informed the meeting that out of the replies received to circulars sent out to members with regard to the proposed alteration of date, time and place of the meetings of the Committee 17 members were in favour of the existing arrangements and four in favour of the alteration. He concluded therefore it was desired that the dates of meeting should not be changed.

Agenda Item 1. Progress Report of the Experiment Station, Peradeniya.

In dealing with this report the CHAIRMAN stated that several Arabian Hybrid coffees had been produced in India which were claimed to be disease-resistant. Seeds of two of these, Jackson's Hybrid and Kent's Arabica had been secured and sown in nursery beds. About 6 acres of land were being cleared in preparation for these coffees. He wished also to draw attention to the mention of Kikuya grass. This grass orginated in East Africa and from there had been introduced into South Africa and Australia where it was giving excellent results. He had received several inquiries recently from Planters with South African connections. Only a small quantity of the grass was in the possession of the Department and it was not anticipated that planting material would be available before next N. E. monsoon.

The CHAIRMAN referred to a letter from Lt.-Col. G. B. DICKSON stating his satisfaction with *Gliricidia maculata* grown in tea on Sarnia estate from cuttings sent by the Experiment Station. The latter gave figures with regard to growth and proportion of successes.

MR. R. GARNIER enquired if any coffee was grown with rubber in Ceylon and asked if there was any known objection to the practice.

The CHAIRMAN replied that he was not aware of any in Ceylon beyond a small block which had been planted in the Experiment Station at the request of MR. C. E. A. DIAS and a small block he had seen in Hewagam Korale of the Western Province. It was however grown in Java and in the Federated Malay States and he knew of no objection to the system when the rubber was young.

Agenda Item 2. Rubber Manurial Experiments, Peradeniya.

The report for 1921 was commented on by Mr. M. Kelway Bamber.

Mr. Bruce Foote remarked on the healthy appearance of the trees and the apparently comparatively low yields and asked if original analyses of the soils were available.

The Chairman replied that the adjoining plots had been analysed in 1905. He proposed to have comparative figures of past and present analyses tabulated for a subsequent meeting.

Mr. Neil Campbell asked if manurial results on trees such as rubber been published in other countries, most manurial results had been worked out on cereals.

The Chairman replied that the Rubber Growers' Association had published figures on rubber and that results on Cacao had been published in the West Indies.

Lt.-Col. T. Y. Wright asked if there was any object in continuing the experiments.

The Chairman replied that he was not prepared to stop them as it would be interesting to see how the results were maintained over a number of years.

Mr. Bamber emphasised the fact that the object of the experiments was to note the effect of a so-called excess of different manurial constituents in bark renewal, health of trees, etc. The yields were up to the average of Ceylon estates.

The Chairman said that he took it from the figures available in this instance not much material benefit was being derived from the application of the manures but the results could not be universally applied.

Agenda Item 3. Two and three-day tapping trials, Peradeniya 1921.

Mr. Holland briefly commented on the report remarking on the relatively low proportion of the yield of the trees tapped on alternate days obtained by the trees tapped every third day. The explanation of this was that the two-day tapping had reached the lower portion of the tree at a greater speed than had the three-day tapping.

As the two-day tapping cuts had now been changed over and started again at the top a relative renewal of this proportion might be expected in 1922.

The Chairman remarked that at the last meeting the experiment had been criticised on the ground that the cuts in the two systems started at the same level. It had however been thought advisable to continue this experiment unchanged and start a fresh experiment on a different basis.

Agenda Item 4 Suggested New Tapping Experiments, Peradeniya.

The Chairman read the suggestions which had been prepared. With regard to the first proposal which was an experiment to compare tapping alternate days throughout the year and daily during alternate months Mr. Sheridan Patterson suggested adding a block to be tapped daily throughout the year for comparative purposes.

The Chairman pointed out that this would reduce the number of trees in each block. He however would note the request.

The next proposal was for a fresh 2 versus 3 day tapping experiment in which the cuts in both system were to be started at the same height from

the ground but in the case of the 3 day tapping a fresh cut was to be commenced every 6 months at the level which had been reached by the 2 day tapping.

Major Oldfield criticised this on the ground of the interval that would elapse every 6 months after changing the cut before the wound response was obtained.

Mr Garnier enquired if 16° was regarded as the most suitable angle for the tapping cut. 22½° was also suggested as a good angle.

The choice of the two angles was put to the meeting with the result that the majority voted in favour of 16°.

Mr. Bruce Foote suggested a change over at least every 6 months in tapping.

The Chairman said that as far as he could remember experiments at Peradeniya over a number of years had revealed nothing in favour of a change over.

Some members also desired the introduction of the V system of tapping into the experiments. The Chairman promised to consider the possibility.

The remaining proposals were accepted by the meeting.

With regard to the proposals under discussion the Chairman said that he would like to consult with Mr. Petch on the subject. This was agreed to.

Agenda Item 5. Individual yield of rubber trees.

Mr. Holland commented briefly on the report of experiment in this connection which had been commenced on April 1st on the Experiment Station on 161 trees planted in 1912 from seed of No. 2 Tree Henaratgoda. The report only dealt with a period of 9 months. His opinion was that the yields were more even than was usual. Two facts might account for this; the fact that all the trees were planted from the seed of one tree and the probability that most of the trees of inferior growth had been eliminated in the thinning given to the plots in 1916. Messrs. Bryce and Gadd were preparing a bulletin on this subject.

Mr. Bruce Foote enquired if there were any figures in Ceylon over large areas to prove the apparently somewhat arbitrary statements that 25% of the trees gave 75% of the yield. He had carried out two somewhat rough experiments with latex yields in 2 fields of 45 and 65 acres, the conclusion was that in this case 35% of the trees gave 50% of the yield.

The Chairman knew of no other individual yield figures from trees of known parentage in Ceylon.

Agenda Item 6. Shot-hole Borer: Burial of Prunings Experiments.

The Chairman summarised Mr. Jepson's report owing to the latter's absence through illness. He exhibited graphs in connection with the report. Mr. Neill Campbell asked if the Director would like castor oil experiments on Bellwood estate coninued, at large number of plants had died not owing to unfavourable weather and replanting was necessary. The Chairman said he would be very glad to have the experiments continued and would supply seed for the purpose.

Mr. John Horsfall enquired if there was any explanation of the fact that areas which had previously suffered severely from Shot-hole Borer were not now so badly affected.

The Chairman remarked that he was glad to hear that such was the case, it appeared to have been the experience of several districts.

Agenda Item 7. Tea Manurial Experiments, Peradeniya.

Mr. Bamber commented on his report. The figures had been brought up to date since 1918.

The question was raised as to whether October was the best month to prune the plots.

The Chairman pointed out that the decision could be postponed for another year.

Agenda Item 8. Coconut Trial Ground Chilaw—Results for 1921.

The Chairman said that he was informed that a meeting of the Sub-Committee appointed to consider the question of the Chilaw Trial Ground had been held immediately preceding this meeting. A report had just been handed to him which he proposed circulating to members. It would then be possible to arrive at a final decision at the next meeting.

The discussion of the 1921 results was therefore postponed with the sanction of the meeting.

Agenda Item 9. Nut-fall of Coconuts.

Mr. Gadd made a statement on this subject. Nut-fall could be divided into fall of the so called "Buttons" and of part-grown nuts. With regard to the former it was found that a larger number of female flowers was produced than could be fertilised. The fall of buttons was probably due to this and not to disease. 151 buttons had been observed to fall from 163 palms during February and March ; drought may have been a cause of this.

The fall of older nuts was different. Mr. Petch had first investigated nut-fall some years ago and had found a Phytophthora fungus to which the fall had been ascribed. Last year however many fallen nuts had been examined which showed no signs of Phytophthora.

It had been found that if collected directly after falling the Phytophthora discolouration was absent. Healthy nuts however if knocked off and allowed to lie about developed this discolouration later.

The Phytophthora fungus is said to attack the branch ; if the branch breaks, the bunch stem is not strong enough to stand the weight of immature nuts and fall results. It may be said therefore that physiological causes also produce nut-fall. The results of spraying with Bordeaux mixture gave no benefit as the weather was dry and not favourable to Phytophthora.

Mr. Long Price suggested that faulty propping in young trees was largely responsible for nut-fall.

Gate Mudaliyar Rajapakse remarked that nuts usually fell during a drought.

Agenda Item 10. Dadaps in Tea. The age or girth at which they become more harmful than beneficial.

Mr. Geo. Brown who introduced this subject said that one saw dadaps of all ages and sizes in tea and it would be of interest to know when they ceased to be beneficial.

Mr. Bamber quoted the ages and sizes of the dadaps in the plots on the Experiment Station. Young dadaps had been planted to replace the old ones which it was proposed to cut out, but he would not like to say that they had become harmful.

The CHAIRMAN said that his impression was that the yields from dadap plots were falling off slightly.

MR. BAMBER promised to look up the figures of the weight of loppings obtained to see if this was falling off at all.

MR. GEO. BROWN asked if a Dadap when old would not tend to produce flowers. It was considered that this flowering need not necessarily indicate "old age."

Agenda Item 11. Translation and Publication in the "Tropical Agriculturist" of articles of interest from "Archief Voor de Rubbercultuur."

MR. SHERIDAN PATTERSON said he had heard that there had been some very interesting articles published in the ARCHIEF VOOR DE RUBBERCULTUUR on the effect of manures on Rubber trees and asked if translations could be published.

The CHAIRMAN promised to comply with the request.

Agenda Item 12. Soil Erosion.

The CHAIRMAN said he did not intend to go fully into this question at the moment. MR. LUSHINGTON in his recent report on the Forest Department had made some interesting observations on the subject which was a very important one. He was aware that estates had individually and collectively taken steps to combat the evil, but Government would like to have the subject reconsidered and he proposed putting the subject on the Agenda at a future meeting.

THE SNAIL PEST.

Before the conclusion of the meeting MR. GARRICK said that at the Planters' Association Committee meeting on the following day several representatives of District Associations intended bringing up the subject of the Kalutara snail. He would ask the Chairman to recapitulate his reasons for not advising legislation against this pest.

The CHAIRMAN replied that legislation meant making the presence of snails on a property an offence. Government could only appoint Inspectors and warn owners that legal action would follow. It would become an offence to have snails on any property. In addition the fact that the majority of Sinhalese were as Buddhists averse to taking life was a serious impediment. Jungles also teamed with these snails and the cost of dealing with such areas would be prohibitive. The forests adjoining the town of Kandy formed an instance. It has been shown that small areas, such as vegetable gardens, can be protected by a ring of sawdust watered with a solution of copper sulphate. Collection also gave good results in many instances.

T. H. HOLLAND,
Secretary, Estate Products Committee.

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA.

For January and February, 1922.

TEA.

The recovery of the tea after pruning was slow, and rather irregular.

41 bushes died and were dug out. Among these were 17 cases of Diplodia, 2 of *Fomes lignosus* and 4 of *Sphærostilbe repens*. The latter 2 diseases were only found in swampy ground.

Plot 155 which received an application of cattle manure in October, 1921, showed a marked superiority in recovery.

6 acres were tipped up to the end of February.

One Gliricidia tree died of Diplodia.

RUBBER.

All young supplies were mulched with dadap leaves after lightly stirring the soil.

CACAO.

A light pruning accompanied by a partial lopping of shade is in progress.

There has been so far no reappearance of the locust pest which did some damage to the dadap shade trees during 1921 and it is hoped that the systematic forking out and destruction of the egg sacks followed by liming the soil has destroyed the pest. The crop is now 3,470 lb. ahead of last season. Sales of best cacao were effected at Rs. 56 per cwt.

COCONUTS.

At an auction sale in February Rs. 40 per 1,000 nuts was obtained for unselected nuts.

About $\frac{3}{4}$ of the area covered with illuk in the Bandaratenne coconut plot has been forked. Three or four more forkings will be required to eradicate the weed.

COFFEE.

All plots have been lightly pruned and the shade partially lopped. Die-back has continued to give trouble. A part of plot 140 G of 8 year old Robusta coffee was sprayed weekly with Bordeaux mixture during November, December and January. Although the weather was very favourable for spraying the disease was not appreciably checked. Further investigation of this disease is required.

Quantities of seeds of "Jackson's Hybrid" and "Kent's Arabica" coffee were received from India during January and sown in nursery beds. 6 acres of new land under jungle cheddy, grass, *Funtumia elastica* and a small area of Cacao are being cleared for the reception of these.

SUGAR-CANE.

The ratoon crop of the canes cut in December 1920 was cut in February 1922. The calculated yields per acre are given below :—

Variety.	Yield.	Position in order of yield at first cutting.
D. K. 74	18·3 Tons per acre	5
131 P	18·2 ,, ,, ,,	6
B.3390	18·1 ,, ,, ,,	4
55 P	17·8 ,, ,, ,,	3
Sealy's seedling	17·6 ,, ,, ,,	1
M.1237	17·0 ,, ,, ,,	2
Striped Tanna	8·1 ,, ,, ,,	7
Striped White Tanna	7·3 ,, ,, ,,	8

FODDER GRASSES.

The Kikuya grass of which roots were received from Australia in November 1921 has been divided out again and is making excellent growth. The transplanted roots of Sudan grass have not done well. Many have failed and it would appear that this crop must be grown from seed as an annual. A small quantity of roots of Napier's grass (*Pennisetum purpureum*) was received from the Philippine Islands ; 3 roots have survived and are growing well.

MAIZE.

The following calculated yields per acre were obtained from 4 varieties originally received from the Bureau of Plant Industry, Washington, in March 1921 :—

	No. of cobs.	Weight of cobs.	Selected seed lb.	Remainder lb.	Total seed lb.
Brazos White corn ...	4,300	2,560	170	960	1,130
W. S. Selection 119 Corn ...	2,000	580	35	340	375
Singleton Strawberry corn	1,220	450	25	240	265
North Western Dent corn	Failed on two trials.				

The varieties were grown in different plots and the results are not therefore strictly comparable. The growth of Brazos White corn was exceptionally fine. The variety would appear very suitable for this district. The seed was carefully selected and further trials with the first 3 varieties will be made this year.

EXPERIMENTS WITH NITRATE OF SODA ON MINOR AGRICULTURAL CROPS.

Sweet Potatos.

Twelve plots of 1/10 acre each (1/5 acres in all) were planted with sweet potatos of 3 varieties. 6 of these plots received one application of Nitrate of Soda at the rate of 400 lb. per acre, two weeks after the planting of the cuttings. The calculated yields per acre were as under :—

Variety.	*Manured.*	*Unmanured.*
Red Jersey ...	6,065 lb. ...	4,630 lb.
Shanghai ...	6,105 ,, ...	7,930 ,,
Jersey ...	4,650 ,, ...	6,985 ,,
Average	5,608 lb.	6,405 lb.

A darker and more vigorous growth of foliage was noticeable in the manured plots but in two cases out of three the crops of tuber were less

Paspalum Millet.

Two plots were sown broadcast, one received Nitrate of Soda at the rate of 400 lb. per acre in two applications, the other was unmanured. Both plots were weedy and the yield was poor. The manured plot yielded at the rate of 13 bush, 4 meas. per acre and the unmanured 8 bush, 4 meas.

Hill Paddy.

Four plots were sown, two receiving Nitrate of Soda at the rate of 400 lb. per acre in two applications, and two unmanured. In this case an increase of only two measures per acre was obtained from the manured plots over the unmanured, and a decrease of 220 lb. per acre in the weight of straw. Heavy falls of rain followed the applications of manure and considerable loss by wash must have resulted.

ROADS.

Over 900 ft. of foundation has been laid and a further large quantity of stone and metal broken. Metalling will be started in the South-west monsoon.

CAMPHOR.

Three further attempts at distillation in a chatty still have been made ; in each case the chatties have given out after use for a day or two.

RAINFALL.

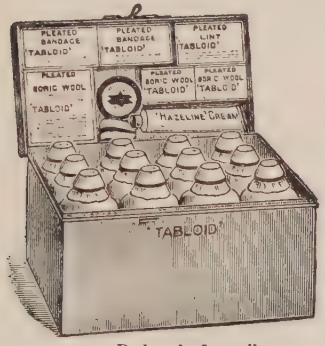
Rainfall for January was 2·86 inches and for February 5·42 inches.

T. H. HOLLAND,
Manager, Experiment Station, Peradeniya.

TRADE MARK 'TABLOID' BRAND

Medicine Case, No. 258

(The Settler's)



Reduced facsimile

Very compact and serviceable. Contains compressed medicaments, dressings, etc., all of the highest quality and unaffected by extremes of climate.

Invaluable for use on out-stations beyond reach of immediate medical aid.

Obtainable at all Chemists and Stores

BURROUGHS WELLCOME & CO., LONDON AND BOMBAY

xx 3355

All Rights Reserved

AGRICULTURAL EDUCATION.

AGRICULTURAL EDUCATION IN CEYLON.

D. H. GRIST, ***Camb. Dip. Agric.,***

Agricultural Instructor, Department of Agriculture, F.M.S. and S.S.

During a recent visit to Ceylon the writer was given an opportunity of studying the system of agricultural education obtaining in that Colony. After detailing the system as there operated, suggestions will be made as to the application advisble for the Federated Malay States. A study of the Ceylon system is valuable because agricultural instruction has there been a settled policy of the Government for about twenty years; and in spite of mistakes that have been made, very material advances have taken place, and the present system would appear to have an assured success.

The following is a brief statement of the educational activities of the Ceylon Government. Under the present system, the direction of all agricultural policy, whether directed towards the training of teachers or others, or in the management of school gardens, is under the sole direction of the

Department of Agriculture, assisted, in the matter of school and home garden work, by local educational committees. The only exception to this rule appears to be in the elementary botany and school garden work taught to vernacular teachers in the Training College for Teachers, Colombo.

At one time there was an Agricultural College at Colombo, directed by the Department of Public Instruction. It was closed in 1900. The reasons given for it are thus stated :

"The work of it was defective simply because the students who went there did so because they thought that they could get Government employment—not Government employment in the Agricultural line—but in other lines."*

Thus, it is supposed that the College attracted the wrong class of student, and this was, in fact, brought about by an unsuitable curriculum.

Too much time was devoted to theory, and too little time devoted to the practical work.

The School of Tropical Agriculture, at Peradeniya, founded in 1916, more effectually filled the needs of the Colony. Its course is of an elementary nature, and stress is laid on practical work in the field. In the class-rooms, lectures and demonstrations are given ; while in the field, students are taught how to handle implements and animals, and the field operations in connection with tea, rubber, cacao, coconuts and other Ceylon products.

The school was designed to attract the following classes of students :

Firstly.—The sons of well-to-do agriculturists ;

Secondly.—Students who intended to devote their careers to practical agriculture as managers or sub-managers of estates ;

Thirdly.—To produce recruits for posts in the Agricultural Department ;

Fourthly.—To provide special classes for the benefit of elementary school teachers, who intended to impart tuition and nature study in the elements of rural economy in village schools ;

Fifthly.—To give village headmen (corresponding to "penghulu" and "lembaga" in the Federated Malay States) short courses in rural economy in order that they might, by precept and example, encourage sound agricultural practice in their respective parishes.

The present staff consists of the Director of Agriculture as Principal, a Registrar, three lecturers and demonstrators, a lecturer in estate accountancy. With the exception of the Principal, the staff is drawn from the natives of Ceylon. The lecturers have undergone a course of agriculture at the Ceylon Department of Agriculture, and obtained the Poona Diploma in Agriculture. In addition, the scientific officers of the Department of Agriculture give occasional lectures in the subjects in which they are experts.

There are two main courses of instruction :

(1) A two-year course in the English language.—At the present time there are twenty students undergoing their first year of this course, and twenty in their second year ;

(2) (a) A Sinhalese Teachers' Class for about twelve certified teachers from the Educational Department.—They undergo the first year's course only, similar to the English students but delivered in the Sinhalese tongue ;

* Agricultural Training in Ceylon—XXXVII—1909.

(b) A village headmen's course of one year, consisting of the ordinary first year's course revised to meet the special requirements of their practical needs.

Vernacular teachers and headmen are admitted to a one-year course in alternate years.

The school is housed in two hostels, and all students pay tuition fees of Rs. 7·50 per mensem, and hostel fees of Rs. 22·50 per mensem.

The school certificate covers the course of instruction of two years. It is given partly on note-book and field-work, and partly on examination results. Special certificates are granted for the vernacular courses. In addition, various prizes are granted in connection with all classes. Scholarships are offered by the Government for the most promising of the students to undergo further training in India.

The courses are largely practical. Each student has a garden to keep in order, and the writer was struck with the keenness shown by the students in the upkeep of their plots. During his visit he also attended lectures in co-operation and accountancy which gave him an idea of the thorough nature of the instruction.

In addition to the above-mentioned activities, the students have a Students' Council which represents the needs of students; a Debating Society, which meets weekly for the discussion of matters of agricultural interest; and a school magazine of an agricultural nature, edited and managed by the students themselves.

A word as to the men produced at the school may not be out of place. The posts in the Agricultural Department filled by former students include sub-inspectors, men for special food campaigns, officers for the co-operative societies, and assistants for the various technical branches.

The Secretary of the Low-Country Products Association stated that there were fourteen old students employed on estates registered with the Low-Country Products Association. "He was pleased to testify to their good work. He found them to be sound, good, reliable boys, and certainly two of them were outstanding men."

THE TRAINING COLLEGE, COLOMBO.

All vernacular teachers at the Training College, Colombo, pass through a course of training in Elementary Botany and Physiology. They have a small college garden, useful for the supply of matter for botany lessons. The botany instruction is thorough. Many of the students' note-books were examined by the writer. They were works of art.

As a preliminary training prior to admission to the School of Tropical Agriculture, the teaching of the Training College is useful; but the garden is too small and the land poor. As mentioned above, the botany work of this college is under the Education Department.

MIDDLE SCHOOLS.

The Director of Agriculture has divided the island and has placed a Divisional Agricultural Officer in each division. One "Middle School" is to be erected in each division, under the supervision of the Divisional Officer. It must be realized that Ceylon shows a wide diversity of agricultural conditions. The middle schools—i.e., intermediate to the School of Tropical

Agricultural and village schools are designed to meet the requirements of each particular local condition.

Vernacular teachers will be trained in such schools. An experimental station will be attached, and distribution of seed, etc., to village schools and individuals made from this centre.

SCHOOL GARDENS.

School gardens were taken over by the Department of Agriculture in 1906. They have accomplished good work and have also been the means of distributing several improved types of vegetable throughout the Colony. The avowed policy of this department is thus stated by the Director of Agriculture, Ceylon: "It is impossible to teach agriculture in the elementary schools and it is important teachers should realize that the main object of a school garden is to provide material for nature lessons, and to provide common objects of ornamental and economic importance with which to train the power of observation of the pupils." In point of fact, the writer is of opinion that training in agriculture is given in such schools, that the boys are taught the production of local crops with the definite intention that they themselves on leaving school, may apply the school experience on a larger scale. It is probable that the present practice of agricultural education is more suited to the local needs than the impersonal nature study of which the gardens were merely to prvoide the material.

School Gardens are of two classes—the village school and the central school gardens. In the latter conferences of school teachers are held, and demonstrations are conducted. To take the schools as the writer found them, the majority of head teachers had been through no instruction at the School of Tropical Agriculture. In spite of this, the keenness displayed in this class of work, both by teachers and boys, is the best recommendation of its effectiveness or utility. At the present time there are 484 registered school gardens throughout the Colony and many more await registration. The organization of school garden work is entirely in the hands of the Agricultural Department and all matters relating to the garden work is referred to the Director of Agriculture and not to the Education Department. The executive is controlled by the divisional officers who are Europeans trained in scientific agriculture. Under these officers work a native staff which include Agricultural Instructors and Inspectors of School Gardens. The Instructors only visit school gardens as their other work permits, while the latter devote the whole of their time to instructional work in schools, planning gardens, judging gardens tor prizes and procuring the plants and equipment for the various schools.

The students in vernacular schools spend one hour a day in the garden, which may vary in extent from $\frac{1}{4}$ acre to two acres.

HOME GARDENS.

An important off-shoot of school garden work is the home garden scheme. The boys are encouraged to apply the teaching of the school garden in the cultivation of plots at home. There are now about 24,000 home gardens in Ceylon.

Of the best school gardens visited by the writer may be mentioned the following:

Owiteganuwa Vernacular School with 250 boys had about 200 home gardens.

Narandeniya School with 250 boys had 150 home gardens.

It should be pointed out that whereas school garden work is compulsory, home gardens are voluntary. So important has this branch of work become that Inspectors of home gardens are to be appointed.

In connection with both school and home gardens, prizes are awarded for meritorious work.

LITERATURE.

A primer of tropical agriculture, adapted as a reader for schools and a senior agricultural reader are the only agricultural books in use, and inadequate. In addition, a journal which records the results of experiments and investigations in native products and of co-operative credit societies is printed for Sinhalese readers and a somewhat similar organ in Tamil.

CO-OPERATIVE CREDIT SOCIETIES.

These form an essential link between agricultural education and agricultural practice. Frequently the application of better methods involves the expenditure of more money than the native can afford. To produce large crops, the planter must make the soil his bank. A co-operative society is the only means by which a poor man can hope to procure loans for approved purposes. It may also become his bank in which to deposit his savings. Co-operative societies thus not only provide the means of increasing profits, but encourage thrift. The working of such societies need not be discussed in this place. It is only necessary to state that each village co-operative society should be self-supporting. The venture should not be a Government one, and the initial capital should be raised locally.

In Ceylon, co-operative societies are of growing importance. In 1919 there were 127 societies, 30 of which had been formed during the year.

The total membership of the societies was 15,160 and the paid up capital Rs. 86,721,46. Government loans were granted to the amount of Rs 13,935.

Government have a controlling influence only on such societies. They provide Inspectors, but the internal arrangements are local and the Government takes no responsibility other than that of encouragement and audit.

The Indian societies are controlled in the same manner.

Other educational activities of the Ceylon Department of Agriculture may be briefly stated. They include assistance and encouragement in village agricultural shows and in demonstration plots. The latter exist in various parts of the Colony and no doubt assist in a considerable degree in the work of dissemination of knowledge and the application in practice of the valuable results attained by the scientific officers of the department.

In passing, the writer would like to record his grateful appreciation of the assistance given to him by Mr. F. A. Stockdale (Director of Agriculture Ceylon), and the officers of his department. Mr. Stockdale arranged with his officers a tour for the writer that embraced a survey of all the activities of his department. The writer's thanks are due also to the assistance accorded him by the Education Department, and also to the Ceylon Government for providing a free pass over the Ceylon Government Railway, and for assistance in other directions.—Agric. Bull. of F.M.S., Vol. IX, No. 2.

SOILS AND MANURES.

CHEMICAL ANALYSIS OF SOILS: ITS VALUE AND LIMITATIONS.

JAS. CRABTREE, M.Sc., F.I.C.

During the past decade an appreciable alteration has been manifested in the attitude of the practical man towards the scientist in nearly every industry, a change impelled chiefly by the increasing intricacies of most industrial processes occasioned by their developments, and one which is likely to progress with further advances. Formerly misunderstood, and regarded as an abstruse dreamer, the scientist is coming to be regarded in his true light; "science" means "knowledge" and the scientist is a knowledge specialist, an individual whose function is the acquisition of information of the fundamental laws of nature which are the basis of every change or process, and the application of such information to the improvement of such processes and changes as are necessary to the most economical production of those materials on which man is dependent for his welfare and comfort.

In the swing of the pendulum away from distrust of the scientist, there is a tendency, perhaps unavoidable, of going too far in the other direction, and expecting too much from this worker. Too often is he regarded in the light of a kind of wizard possessed of mystic powers and store of knowledge, an impression which it is to be feared, is in some cases not violently discouraged by the individual himself. He is, however, but human, and probably encounters more insoluble problems than most of his brothers in other walks of life; a closer comprehension by the latter of the limitations of the knowledge at his disposal, and the difficulties which beset his way, cannot but lead to a greater appreciation of the results he obtains.

In endeavouring to arrive at some conception of the value and possibilities of the work of the scientist, it should be remembered, that for thousands of years, man has been acquiring information by the slow and labourious method of "trial and error" and applying this information to his methods by the process of the "rule of thumb." Astonishing as has been the advance from this position within the past century, it must be obvious that the comparatively short study of modern times cannot possibly be expected to have thoroughly elucidated, considerations of modern developments apart, even the phenomena observed and methods developed, during those thousands of years. In no branch of study is this more apparent than in Agriculture, the most ancient of the arts, and the most complex of the sciences. In no science has so much been learnt in a short time, or so little relative progress been made in comparison with the information acquired. This is not surprising, when we reflect that in the growth of any plant are involved considerations of plant physiology and heredity, physical conditions (soil texture, temperature, water, air and light supply), chemical problems of soil reaction and plant food (themselves involving questions of bacteriological,

protozoological, and fungal changes), with extraneous modifications occasioned by diseases and pests of the plant. Difficult as is the study of any single one of these aspects, the correlation of all of them essential to the full consideration of any Agricultural problem, must be still more so, especially as the undue or insufficient stressing of any one aspect may profoundly modify the conclusions to be arrived at. The information to be obtained by the study of any one only of the above mentioned aspects is limited, and it is the limitations of the ordinary routine chemical examination (or analysis) of soil, that it is intended to discuss in this article.

By "soil" is generally understood any exposed portion of the earth's surface which will support the growth of the higher plants. It consists essentially of two classes of material, disintegrated rock, and "organic matter" or plant and animal debris : variations in extent of disintegration of the former, and the chemical changes it has undergone, and in the amount of modification of the latter, determine the resulting type of soil, which, as is well known, may vary within very wide limits. Nevertheless, the essential components are same in all cases, and it is their relative proportions, climatic conditions apart, which determine the extent of the ability of the soil to support plant growth. It is with the determination of the said relative proportion that chemical analysis is concerned.

The chief components which influence plant growth in any way, and with which the analyst chiefly concerns himself are :— "Organic matter" (containing essentially nitrogen, carbon, hydrogen and oxygen). Sand, (and other matters insoluble in strong acids) Iron, Alumina, Lime, Magnesia, Potash, Soda, Sulphates, Carbonates, Phosphates, Chlorides (sometimes).

The results of a typical so-called "complete" analysis of cane soils of this colony are set below, as an example

	Total	
Water	3·50	
Loss on ignition (chiefly organic matter*) ...	8·12	
Sand and insoluble	73·58	
Iron oxide ...	4·51	
Alumina ...	8·98	
Lime ...	·20	
Magnesia ...	·50	
Potash ...	·21	·020
Soda ...	·20	
Sulphuric acid ...	·08	
Phosphoric acid ...	·09	·010
Carbonic acid ...	nil	
Hydrochloric acid ...	·03	
	100·000	

Of these substances, the materials directly essential to plant growth are the nitrogen, potash, phosphoric acid, lime, magnesia, iron and sulphuric acid, though the cases where the soil does not contain a sufficiency of lime,

* Containing Nitrogen ·25

magnesia, iron or sulphuric acid for the requirements of any crop being rare, the first three ingredients may be regarded as the real essentials. All others are of indirect interest only ; their respective roles are often more or less imperfectly understood, though often of predominant importance ; a consideration of them is outside the scope of this article.

Now, an inspection of the above soil (or preferably a "mechanical analysis" showing the relative proportions of articles of different diameter) will have shown the analyst that the soil is a fairly heavy clay, and from his previous experience of such soils, he is able to say from the chemical results above that this is a soil of distinct potential fertility i.e. it can produce substantial crops of various cultivated plants for a considerable period, given reasonable husbandry and climatic conditions). He might be a little doubtful about the lime content especially as it is less in amount than the magnesia; he might also reasonably doubt the ability of the phosphoric acid to hold out over a long period ; a determination of the so-called "available" proportion of these substances mentioned below would help in some respects, but unless the analyst had already had information of the behaviour of that particular class of soil under the conditions and crops under which it was proposed to work it, he could not with confidence state that such and such was the best method of treatment, or of manuring.

Now, suppose a crop of say sugar-cane is grown on his particular plot of land, and assume that the roots of the cane feed on only the upper 18 inches of soil; assume also that an acre of this soil to that depth weighs 3,000,000 lb.; there will then be present in this amount of soil 7,500 lb. of nitrogen, 6,300 lb. of potash, and 2,700 lb. of phosphoric acid by the above analysis. (Even this does not represent the whole as there is still present some potash at any rate in the "insoluble" portion.) The amounts "available" to citric acid will be, potash 200 lb., phosphoric acid 100 lb. Now, if in cultivation a crop of cane were obtained of, say, 40 tons per acre, it would, according to analyses by Stubbs in Louisiana, remove in the whole crop, canes and leaves, about 40 lb. of nitrogen, 90 lb. of potash and 60 lb. of phosphoric acid, that is between 1 and 2 per cent. of the total amount and 60 per cent. of the "citric acid available." On the face of it this would seem to the lay mind to indicate that there was no need to apply any manure of any kind to obtain a crop of this magnitude, yet we know from experience, that in actual cultivation, this soil would, if left unmanured, probably not give us more than about 10 tons. The explanation of this is, that the plant is not able to use the major portion of the material the analysis records as being present; only a quite small proportion of the plant, and it is largely on the rate at which the stored-up materials become available that the productivity of the soil depends. The difficulty of ascertaining this rate will be realised when one notes that the analyst obtains his amounts of plant food from the soil by dissolving it out with concentrated acids, usually at high temperatures; moreover, his results will vary according to the strength of the acid he employs, the temperature he uses, and the duration of time over which the acid is allowed to act on the soil. Now the plant has neither strong acid, nor high temperature at its disposal, and moreover takes months in abstracting from the soil the materials it requires. It does not require much reflection to appreciate that

there will be substantial discrepancies between the analysis made by the analyst and that made by the plant. Herein lies the difficulty of the whole matter. The exact manner in which the plant dissolves out the mineral ingredients at any rate, is not as yet thoroughly understood, and the difficulty of simulating, in the short time at the anlyst's disposal (hours or days) what the plant effects slowly over a long period, has so far proved insurmountable. Many attempts have been made to do this the most successful of which was by Dyer, who in 1894, estimated the acidity of the roots of a large number of plants, and finding it to be on the average about equal to a one per cent. solution of citric acid, used this latter solution to digest soils for a considerable number of hours: the amounts of mineral constituents he extracted in this way he considered as immediately available to the plant, and found that his results were borne out by the cropping figures of the soils of the Rothamsted and other experiment stations. The method seemed at first sight simple and alluring, but it has since been found that the acidity of the root sap has very little to do with the solution of the mineral ingredients, and that far from being simple the reaction involved are hedged around with numerous complications, a consideration of which would be out of place here. Nevertheless the method has proved to be of considerable value when used in connection with manurial plots and is practically in world-wide use. Other investigators have used different solvents such as dilute hydrochloric and nitric acids, aspartic acid, ammonium citrate, and so on, but to no particular advantage. Even in this method, however, it is impossible to draw general conclusions, for different crops require different amounts of mineral ingredients, and different soil reactions, and inferences drawn from one crop would probably fail with another.

About 1890 several German investigators, losing faith in the abilities of chemical analysis to give information as to manurial requirements, instituted the method of "pot culture" in which crops under inquiry are grown for longer or shorter periods in pots containing the particular soil about which information is required, using different methods of manuring; in short a condensed series of manurial trials. The method, however, proved too cumbersome and was not directly applicable to field conditions, and though of great value in studying soils problems, pot culture is not now used in the routine of soil "analysis."

The question the practical man requires an answer to, from the analyst, is, "what manuring does my soil require *now* to give me the best results at the least cost?" and it is, with this in mind, that the subject is being discussed here, for after all, that is all the majority of practical men are interested in. With analytical methods only at one's disposal a definite answer cannot be given to this query. The only really reliable information is that obtained from actual field trials on the particular class of soil under enquiry in which varying amounts of different manures are applied and their results on crop production accurately recorded from year to year. It is in connection with these field trials that analysis is of the greatest value in the light of the question we are considering. When definite results have been obtained from field trials on the broad general types of soil in any given country or district, and analyses have been made of the soils of the plots from time to time, then definite advice can be given on the handling

of any particular field elsewhere by sampling the soil on it, comparing its analysis with that of the manurial plots about which we have accumulated so much information, and by means of this comparison, advising in the light of the results obtained on the particular type of soil in the field experiments. In the most progressive countries the agricultural districts are being mapped off by "soil surveys" into areas of the different soil types, classified according to the results of chemical and mechanical analysis, and experiment stations established on those types of sufficiently large area to warrant it. The correlation of any particular field with the fields of the plot trials is then established by analysis, and the advisor thus placed in really sound position to advise on treatment. The matter is not of course as simple as this statement might make it appear: it is the principle only that an attempt here is being made to explain.

Cases of pronounced infertility are a much simpler matter and here the ordinary chemical analysis is on much safer ground; these cases usually result from the marked absence of some plant food, or from some pronounced reaction of the soil, or presence of an injurious factor. These can almost always be traced.

It would be as well to point out here that information obtained from plot trials may not be indispensable where an analyst has been working for some years with soils of one or two different types and has been at the same time able to follow up the performances of these soils in the field. Here his long experience will serve him: he has in fact been accumulating during those years of experience precisely that information which the plot trial is designed to give in greater detail. Unfortunately, however, this experience is often of a nature that cannot be recorded in terms of words and figures, while the statistics of the experiment station plots are at all times available to others.

To recapitulate then :—

Chemical analyses of soils alone can, in the present state of our knowledge, tell us whether a soil is or is not, fertile : i.e., capable, with reasonably good husbandry and climatic conditions, of supporting crops of plants of value to man, for an indefinite period. This information is ordinarily of value only to an agriculturist taking in virgin land or entering on operations in cultivated lands of which he has no previous experience.

It can elucidate cases of pronounced infertility in apparently fertile lands.

Its greatest value directly to the everyday operations of the practical man is usually in conjunction with field trials, for in this way only can really reliable information be given about such problems as manuring and general cultivation.—Journal of Board of Agriculture, British Guiana, Vol. XIV, No. 4.

PESTS AND DISEASES.

THE "MURDA" DISEASE OF CHILLI (CAPSICUM).*

G. S. KULKARNI, M. Ag.,

Asst. Professor of Mycology, Agricultural College, Poona.

This is a very serious disease, nay, in fact the greatest enemy of the chilli plant, occurring in most parts of the Bombay Presidency. It is, therefore, well known to the cultivators who call it by various names as *murda*, *goja*, *macoda*, and *mirya* in the Daccan, *chandiroga* or *mullagariroga* in the Karnatak, and Kokadva in Gujarat.

The disease makes its appearance first in the terminal or axillary tender shoots of the plants. The leaves of the attacked shoots get curled up usually outwards and droop down. Often they show much distortion and wrinkling and are reduced in size. They gradually dry up and drop down. New shoots come up, which are in turn attacked and destroyed. The growth of the plants is thus checked. The disease appears at any stage of the plant. If it begins at the seedling stage the affected plants never produce any flowers and fruits. If the plants are attacked in the flowering stage most of the diseased flowers wither and drop down and the few that escape from berries which are also soon spoiled. The attacked fruits are much smaller than the normal ones and are curved. The disease gradually spreads to the lower branches, and as the internodes of the attacked branches are shortened the leaves appear as if they are in clusters and are reduced to minute scale-like structures. In such a highly malformed stage the plant at times is recognized with great difficulty. Such a severe attack was noticed this year (1920) near Poona in the Baramati valley where in most of the fields the crop was a failure. Reports of ravages of this disease have also been received from the tracts of Bijapur, Gokak, Kolhapur, Khed, Amalsad and Anand.

The cause of this disease is the same mite which causes the *tambera* disease of potato†. That the potato mite has something to do with the chilli trouble was suspected by the writer while the *tambera* disease was being studied in the year 1919, but an attempt to produce the disease in chilli plants by inoculation experiments was not successful as mentioned in the previous paper, probably because the experiments were done rather late in the season. The study was therefore postponed for the next year. Early in June, 1920, the disease was noticed on the chilli seedlings in the writer's compound, and an examination of the diseased plants gave clear proofs of the presence of a mite agreeing in all its stages with that on potato. Inoculation experiments were therefore at once started. Three sound, twenty-days-old potato plants in pots were taken. Two were used for inoculation

* Paper read at the Eighth Indian Science Congress, Calcutta, 1921.

† Mann, Nagpurkar and Kulkarni. The Tambera disease of potato.—Agri., Jour. India, pt. XV.

and the third for control. Inoculation of the plants was made by putting on them affected parts of the chilli plants containing the mites. The infected plants began to show on the ninth day distinct symptoms of attack, viz., the twisting and curling of the leaves with a reddish tinge and the erect bunching habit of the shoots, and on the thirteenth day the tender leaves on one plant began to dry up; on the sixteenth day the affected shoot was completely killed. The control plant remained healthy during this period. Experiments were then made with chilli plants which were inoculated with the potato mite. Six sound chilli plants in pots were chosen, four for inoculation and two for control. Inoculated plants on the 12th day began to show the typical symptoms of the *murda* disease. The leaves became twisted and crumpled, were much reduced in size and had a number of moving mites on them. The control plants remained quite healthy all the while.

The cause of this disease, which had baffled our efforts so long, having been discovered, attempts were at once made to treat the diseased plants with the lime-sulphur wash. Spraying experiments were made at seven different centres in the Presidency-Gokak farm and Goshanhatti in the Belgaum District, Tikkoti and Muttagi in the Bijapur District, Baramati and Karkumb in the Poona District and at Rukdi in the Kolhapur State Only one spraying was given. Favourable reports as to the efficiency of the treatment were received from all the above places. The results were most successful especially at Gokak and Rukdi, while in other places they were not so marked as the disease was in a far advanced stage at the time of treatment. These preliminary trials show that only one spraying is enough to control the disease if done at the time when the disease just appears. The cost of spraying per acre came to Rs. 10.

Search for other host plants of this mite has shown that besides *guar* (*Cyamopsis psoralioides*), it occurs on Zinnia, Dahlia, Tagetes, *Mirabilis jalapa*, Cape Gooseberry, *Amaranthus polygonus* and *Physalis minima*. In the case of Zinnia, the affected plants got stunted in growth, the leaves are twisted and crumpled in various ways and no flowers are borne. If the flowers appear, they are few, and are much reduced in size. Often the flowering parts are transformed into leafy shoots. Early in the season this year, a few affected Zinnia plants in front of the Agricultural College buildings, Poona, attracted the writer's attention, and examination of these showed on the under-surface of the leaves any number of moving mites agreeing with those on chilli. Cross-inoculation experiments were made, using the mite obtained from one host to inoculate the other. The results were quite successful, showing the typical symptoms of the disease in each plant. The Zinnia disease was one of the constant complaints received from the public, and the worst attack noticed in Poona during the last six years, occurred this year (1920) in the Government House Gardens, Ganeshkhind, where all the Zinnia plants were completely spoiled. Its ravages were also reported from the Victoria Gardens, Bombay. No spraying trials were undertaken as the season and the disease had far advanced when the reports were received.

As the mite has already been described in the previous paper, * it is not necessary to repeat the description here.

* Agri. Jour., India, XV, pt. III.

It is hazardous, no doubt, to attempt to identify the mite, as it is the work of a specialist. However, the following is the venture made by the writer.

In the Indian literature on mites a Litchi disease has been described by Misra*. The mite in the attacked parts of the plant causes a peculiar hairy growth and it is said to be a species of *Eriophyes*. There is another disease on cotton and jasminum. Here too in the attacked parts the mite produces wooly growth and it is said to belong to a species of *Phytoptus*. The chilli mite differs both in its morphological characters and in the effects produced on the host from these two species. Carpenter's† statement that the mite may belong to a red spider group (Tetranychidao) does not seem to hold good. The Tetranychidao‡ have six segments in their legs, while the legs of this mite have five segments. The mite comes very near to the yellow mite of the gonus *Tarsonymus* described by Watt and Mann.§ The description and illustrations of the yellow mite agree completely with those of this mite. The peculiar sucking discs with two hooklets at the end of the legs—characteristic of Tarsonymidæ¶—are also noticed. It may therefore be a species of Tarsonymidæ.—Agricultural Journal of India, vol. XVII, Part 1.

THE BLACK FLY OF CITRUS AND OTHER SUB-TROPICAL PLANTS.

S. F. ASHBY, B Sc.

Mycologist, Imperial Dept. of Agriculture for the West Indies.

The black fly (*Aleurocanthus woglumi*) was introduced into Jamaica from India on infested food plants within the last 10 to 15 years. From this focus in the New World it has spread to Cuba, New Providence, the Canal Zone, the Republic of Panama and Costa Rica, and is continuing its spread from these new centres.

It was probably introduced into the Canal Zone between the years 1912 and 1914 the introduction taking place on more than one lot of infested food plants.

This report is based on an intensive study of this pest in the Canal Zone made from June 1918 to August 1919.

The introduction and establishment of this pest in widely separated areas has taken place through nursery stock or infested individual food plants, including cuttings for propagation. Within a region this method of spread is supplemented by the natural flight of the adults, by their carriage on vehicles and trains, and on the clothing of persons passing or working among infested trees.

---

* Agri. Jour., India, VII, p. 286.

† A new disease of the Irish Potatos, Phytopathology VIII, p. 286.

‡ Brown, Max. Animal parasites of Man, 1906, p. 355.

§ Watt and Mann. Pests and Blights of Tea plant, 1903, p. 360

¶ Brown, Max. Animal Parasites of Man, 1906, p. 356.

The important food plants of this insect in the Canal Zone are : *Ardisia revoluta*, various species of the genus Citrus, *Coffea arabica*, *Elaeis melanococca*, *Eugenia Jambos* and *E. malaccensis*, *Lucuma mammosa* and *L. nervosa*, *Melicocca bijuga*, and *Mangifera indica*.

This insect under certain conditions, injures seriously plants infested by it, but no plants killed by it have been found in the Canal Zone and Republic of Panama.

There are six stages in the life history of the black fly namely, the egg, three larval instars, the pupa, and the adult. The life history is not clear-cut and there is a decided over-lapping of stages.

The length of time for the completion of one generation ranges from 45 to 113 days. *The duration of the various stages are : Egg, 11 to 20 days ; first larval instar, 7 to 16 days ; second larval instar 5 to 30 days ; third larval instar, 6 to 20 days ; pupa, 16 to 80 days ; adult, probably 6 to 12 days.

There is a great mortality in the various stages, only 22·5 per cent of the individuals of 700 eggs reached maturity.

The natural climatic factors that tend to hold the insect in check in the Canal Zone are : Drying out during the dry season and the heavy rain during the wet season.

Five species of coccinellids and one species of Chrysopa have been found to be predacious on the various stages of *Aleurocanthus woglumi* but they are not as yet sufficiently abundant to be important factors in its control. No internal parasites were found.

The black fly can be controlled by contact insecticides. Five and ten per cent. kerosene emulsions, fish-oil soap at the rate of1 pound to 2 and to 4 gallons of water, and nicotine oleate have given good results.

There is a possibility that this insect may gain entrance into and become established in the United States, particularly Florida. It already occurs in Cuba and Nassau, New Providence. The way in which it is most apt to be introduced and become established is through infested food plants, such as nursery stock or individual plants, or as cuttings for propagation. This is the way in which it was brought from the Old World to the New and is the way in which it is continuing its spread to widely separated parts of its new home.

About six years ago a planter in Jamaica found some of his grape-fruit trees, previously badly infested by the black fly completely cleared from fly and scales, and noting ants' nests present put nests taken from logwood on all his trees. Within a year they were clean, and have remained so. There was no sign of any general new scale infestation though a few scales were maintained in the nests. It is necessary to have the right variety of *Cremastogaster brevispinosa* : it builds nests which are long and pointed when full sized. If it is not already present on logwood, Anona sp., etc., in Bahamas a few nests could, no doubt, be obtained for experiment from Jamaica with the help of the entomologist.

---

* Summary of BULLETIN, No. 885 of the U. S. Dept. of Agriculture.

Note by Entomologist, Ceylon :—This species is quite common in Peradeniya and we have had specimens from Colombo ; it is doubtless widely distributed.

Here it is attended by the large red ant *Œcophylla smaragdina*, but I have not observed any other ants feeding on it.

APICULTURE.

BEE-KEEPING NOTES.

Mr. R. Whyte, a well-known authority on bee-keeping, writing on the subject of Vitamines in Honey, says: "As a digestive stimulant, a rapidly absorbed economical food, a muscular nerve tonic, honey has its reputation;" but it is not generally known that wide commercial use is now made of it in producing Vitamine preparations for ricketty children and others. This is a high tribute to the dietetic value of honey which should be given due prominence in advertisements to the general public.

Some time ago the Secretary of the Ceylon Bee Keepers' Association addressed the Bee World on the subject of tainted honey. The December number of that periodical contains an interesting letter from Mr. F. Bondikev of Delhem, Berlin, which throws further light on this question. He says: "I read with great interest the article by Mr. Drieberg in the October number of the Bee World on bitter honey. An acquaintance told me the same concerning German East Africa, and in this case also *Hevea* was concerned." Mr. Bondikev then quotes from ancient writers with reference to the poisonous honey. Tenophon relates how the soldiers who consumed the honey of Pontus were attacked by a kind of dysentery, some becoming raving and others unconscious. Theophastus also refers to poisonous honey. While Aristotle mentions a honey which makes people mad but cures lunatics! Mr. Bondikev believes that there is also a reference in Moltike's Turkish Travels to the honey from *Azalea pontica* and *Rhododendron ponticum* which is said to be poisonous, but whether injurious to the bees themselves is not clear. He points out that when bees get on to a Buck-wheat field in full bloom the bees "drift" and turn ferocious.

The average life of a worker bee according to Dadant is 35 days. Mr. W. Stokes of Romileo, Cheshire, who writes on this subject, is inclined to revise this estimate. He says: "Though some bees would meet with an early death, it is not fair to assume that the same number will die in the first few weeks as in the latter weeks. I would suggest that a more reliable average would be 45 days, on the basis that most of the bees would do 30 days' field work, and the longest lived 60 days."

Hints.—(1) In feeding bees do not feed at the entrance or out of doors, as it causes other bees to rob: always feed on the top or over the brood nest. (2) When you observe bees hunting about your hive, trying to get in, be sure robbing is going on. It is then wise to close up the

entrance of weak hives and only allow an opening sufficient for a single bee. and sprinkle weak carbolic acid solution about the front of attacked hives or where bees are crowding. (3) When bees are hanging out in front of a hive, it shows that they are uncomfortable in it, or have no room. They should be given more air or more room according to circumstances. Shading the hive from the sun in very warm weather is beneficial. (4) If you give bees plenty of room before the honey-flow, and keep them busy at comb-building, they will rarely swarm. If once they feel themselves crowded, and get the swarming fever, there is nothing that will keep them from going. (5) Honey should not be taken from a hive soon after it is stored, as it is then watery, unripe, and likely to become unfit for use very soon. Give the bees time to ripen the honey before removal, when it will be found nice and thick and with a good rich flavour. (6) The old queen always accompanies the first swarm. (7) A queenless stock will raise queens at once if it has eggs or larvæ under three days old: and the queen should hatch within a fortnight. Mr. Yasno Hiratsuka of Gi fu-ken, Japan, writing to the Journal of the *Apis Club*, Benson, Oxon, says: "I have read with great interest the notes on *Apis indica* by Capt. Campbell and Mr. Drieberg. A. Indica is not identical with the German bee, as some English bee-keepers' surmise." He then goes on to say that the bees of Japan (*A. Japonica*) are a variety of the Indian bee, and points out a peculiarity in their method of fanning which is with their heads away from and backs towards the entrance, which is exactly what our bees also do. The western bees adopt the opposite position in fanning. (It will be recalled that Capt. Herbert Campbell, while in Ceylon, kept bees at Nuwara Eliya.) (8) A robber bee is easily recognised by its quick movements and buzzing about the hive entrance, occasionally trying to settle on the alighting board. When a hive is opened and such bees are observed about it should be quickly closed again. (9) During the honey harvest the entrance might be widened and narrowed down again after it. (10) In seasons of scarcity, due to severe drought or heavy rain, bees should be fed, and they will repay the attention given. (11) The best way to guard against robbers and other evils is to keep the colony strong. (12) Bees won't tolerate nervous, jerky handling. Handle gently; and with an occasional good puff of smoke one can do almost anything with bees. Smoke the bees a little at the entrance before opening a hive. (13) When stung do not lose any time in scraping the sting off: do not pull it out as you are likely to drive more poison into the wound. (14) About 5,000 English bees go to the pound. In the case of *Apis indica* there would be more. Who can tell us? (15) Before melting old combs for wax, immerse in rain water for 24 hours. This gives more and better wax.

C. D.

LIBRARY.

REVIEW OF APPLIED MYCOLOGY.

The Imperial Bureau of Mycology has undertaken the publication of a monthly abstracting journal, the Review of Applied Mycology, for the purpose of supplying, month by month, a summary of the work published in all countries on the diseases of plants and various other aspects of economic mycology.

The first number will be issued in January, 1922, and it is hoped to complete a volume of between four and five hundred pages annually.

Mycologists and plant pathologists often find it difficult to keep themselves informed of the progress of work in other countries. The publication in which an account of current work is given are very numerous and are scattered through a very large number of journals, many of which only occasionally contain an article of interest. There are few, if any, libraries in which all these publications can be found, while the working mycologists in the overseas parts of the British Empire often have access to only a small proportion of them. The Committee of the Imperial Bureau of Mycology have accordingly felt that it is in the highest degree desirable to start the publication of a compact yet comprehensive survey of current literature dealing with the various aspects of applied mycology, on the lines of the Review of Applied Entomology published by the Imperial Bureau of Entomology. This survey will be in the form of abstracts in which especial attention will be given to the diseases of tropical crops and similar matters of interest to mycologists in the overseas parts of the British Empire.

It is fully recognised that the success of the Review will depend largely on the co operation of all those interested in the practical applications of mycology and plant pathology, and the Committee earnestly appeal to all such persons to aid by the prompt supply of local publications and by keeping the Bureau advised of developments likely to be of interest to workers in other parts of the Empire, such as the outbreak of new diseases or the spread of old ones.

Though the chief object of the new journal is to give an up-to-date summary of the current work bearing on the practical application of the study of plant diseases to the reduction of the wastage due to such diseases in agriculture the fundamental researches on which most progress in this direction is based have a wider appeal. The Review will enable all those who are interested in the progress of science to follow the development of one of its younger branches. The pure scientist will, it is hoped, find many side-lights on the wider problems on which he is engaged, while the practical grower will be able to learn the experience in other countries with improved methods for controlling plant diseases.

E. J. BUTLER.

DISEASES OF ANIMALS IN SOUTH AFRICA.*

The Author states the prime object of the work to be a concise statement of the more serious diseases of farm animals in Sourh Africa as distinct from other lands. The diseases mentioned however are not confined to South Africa, and are met with wherever farm animals are kept. A glance at the list of contents shows that its usefulness is not so circumscribed, and the volume to be a very useful compendium of practical information to every stock owner.

Generally speaking affections other than parasitic are omitted and the diseases described are classified as caused by vegetable parasites. (i.e., bacterial diseases), animal parasites, insects, worms, and ultra-visible viruses. This is a somewhat novel and difficult classification, for example—Rabies under vegetable parasites, Acariasis under animal parasites, and Phthiriasis under insects. However, a useful index provides all that is required.

A suggestion is made that the B. Anthracis while being an obligatory parasite in cold climates may exist faculatively in hot climates. An interesting point in connection with this disease is its prevalence amongst East Indian goats and the hair infection of these animals.

Considerable numbers are shipped weekly to this country. The disease is not prevalent amongst them before shipment, but during the 24 hours transit while crowded on board ship many cases occur, and for three days after landing, while in the quarantine station. Cases then fall off. Cattle brought over on the same ship are very rarely affected. During 1921, 56,857 goats and sheep were imported—397 died from Anthrax after arrival. 13,573 cattle and buffalos were imported with these animals. Anthrax cases—Nil.

During recent years this disease unfortunately has cost human lives, by infection conveyed by shaving brushes. There is no doubt as to the grave danger in connection with East Indian goat hair.

The Author favours the opinion that Swine Plague or Swine Septicæmia in most cases is a complication of Swine Fever. That may be so in countries where Swine fever is largely met with. In this country Swine fever is not a common disease. The writer experienced a very serious outbreak with over two thousand deaths of Swine Septicæmia as a distinct disease from Swine fever—a typical Septicæmia and of a highly contagious nature.

Much information is given with reference to tick borne diseases, also the trypanosomiases and coccidiosis. One would wish to see in the next edition good illustrations in these sections both of the carriers and the parasites commonly found which would help very much identification in other countries.

In common with printed matter generally the price is somewhat high, nevertheless the volume can be recommended with confidence to all interested in the welfare of live stock.

G. W. S.

* Diseases of Animals in South Africa by C. R. Edmonds, M.R.C.V.S., Asst. Chief Veterinary Surgeon, Rhodesia. Published by Bailliêre Tindall & Co. Price 25s. net, Postage 10*d.*

GENERAL.

RATES OF INTEREST CHARGED IN GRAIN CULTIVATION IN CEYLON.

T. B. P. KEHELPANNALA.

PADDY.

Inviolable custom has regulated seed interest on cereals for propagation and consumption at certain fixed ratio. The interest levied on seed paddy "Bittaravi" is rated at five lahas* for every ten lahas or a pela of paddy-approximately half a bushel for every bushel of paddy borrowed. The same rate rules for paddy loaned for consumption, called "Ehevi."† It is a noticeable fact that compound interest does not generally run in the case of paddy borrowed for sowing or consumption. The reason is clear. The established rule warrants the return of paddy loaned for either purpose within the borrowed year; it is contrary to custom to exceed the year-limit, which seldom or never happens.

The peasants' most necessitous time to borrow paddy is during the "Ehela-Pohon Maha,"‡ the ploughing season, when he requires paddy for food. And the recognised rule is to return the loaned paddy with interest to the lender at the next harvest, which entails a period of at the most seven months in the case of fields cultivated with "Ma-wi" for "Maha" season. In districts where fields are cultivated both for "Yala" and "Maha," the borrowed paddy should be returned at each succeeding harvest. "Hatiyal" and "Sudu-vi" take six months to ripen; "Hondaravala" five months; and "Hineti" four months. No interest for paddy is charged for paddy lent in "Ill-Unduwak Maha"—November-December. This is the blossoming season, about two months preceding harvest. The "Ill-Unduwak Maha" is the month of the greatest scarcity in the year in the life of a Kandyan villager, when his food-supply becomes exhausted. This fact is evidenced by the popular adage, "Unduwak mahata undu kudut nè": Even undu (*Phaseolus mungo var. radiatus*) powder is not to be found in "Undu-wap-maha."

Should exceptional circumstances prevent the borrower of seed paddy from returning the paddy with interest at the first harvest immediately following the loan, it is usually repaid with double interest at the second harvest, i.e., two bushels for one bushel. The necessity for this seldom or never arises, except in arid districts where cultivation facilities fail, as a result of drought or insect pests. No compound interest is levied for "Ehevi" paddy borrowed for consumption, even if it exceeds the time-limit within which the paddy is to be returned.

* The laha, which varies in size, is the standard measure in every Kandyan village. The late Mr. R. W. Ievers, C.C.S., says, that in the North-Central Province "the laha is the basis of all calculations for all Government assessment."

† Literally "extinct-paddy," paddy lent for consumption, other than that taken for seed. The word "Ehevenava" is peculiar to the Kandyan dialect, and means "to become extinct."

‡ June-July.

No villager ever grudges to repay borrowed seed paddy with the allotted interest, as intentional non-return is construed a sin and a standing disgrace, which excites the righteous wrath of the gods, and will render future crops unproductive.

In "Ande"* fields, the seed paddy is invariably supplied by the land-owner. In any case the seed paddy with the accumulated interest is first removed from the "Mulgoda" or "Beta,"† and the remainder equally divided between the land owner and "Ande" cultivator.

In the Anuradhapura District no interest is charged for "Bittaravi" (seed paddy), which in the dialect of that district is appropriately termed "bimagiyavi," literally, "paddy gone to the ground," if it is supplied by the "Ande" cultivator. If the land-owner provides it, neither the seed paddy nor the interest is taken from the paddy crop at the harvest, the crop in entirety is evenly distributed between the landlord and Ande cultivator, as such exaction is thought disreputable. This wholesome example deserves to be copied by Kandyans of other districts.

But the levy of interest on seed paddy is considered just and equitable, considering the difficulty involved and the care that has to be exercised in the selection, storing and preservation of seed paddy, which only a limited few of the richer landlords in a village could afford to do.

Defective seed paddy is often the cause of the failure of a crop. The local supply frequently runs short necessitating the acquirement of seed paddy from other parts. During the recent rice crisis, the demand for seed paddy was so great that the customary interest in kind was flatly rejected, and Hineti seed paddy was sold at the record price between Rs. 5 and Rs. 8 per bushel.

The selecting of good seed paddy is one of the first essentials in paddy cultivation. This has been recognised in every country, even legislative enactments have been passed in places like Japan, America and India to regulate the provision of good seed paddy.

Paddy intended for seed should not be taken from a heap of grain which has been stacked for more than one day as its germination may be spoilt by fermentation.

Seed paddy is measured by the laha,‡ ten of which make a bushel.

OTHER GRAINS.

The same rate of interest as is payable on paddy is exacted from "El-paddy"§ and "Amu"¶ (*Paspalum scrobiculatum*) also.

---

* Fields let out by a land-owner to another to cultivate, the former to half share of the paddy crop and straw as "Gankara Ande" (land-owner's share).

† The whole crop of paddy. [HON. MR. PANABOKKE tells me that in Bintenna under Soraborawewa, where he owns an extensive tract of paddy land, the "Ande" cultivators do not give him half share of the crop as in this district.]

‡ For sowing the laha is required to be a measure that holds seven neli, eight lahas of which make a pèla of paddy. For dealings, the laha varies in size, and requires five, six and seven neli to make a laha.

§ Unlike paddy, the land-owner is entitled only to 1/3 share of the produce in Ande-chenas.

¶ The land-owner gets 1/3 share of the produce in Amu chenas.

Among grains, Kurakkan (*Eluesine coracana*) is the only cereal from which seed interest is exempted from ancient times. The custom prevailing from Kandyan times followed even up to date, in districts where kurakkan is abundantly grown, is for the land owner to remove during harvest, only a big basketful of the best grown ears of the first fruits as royalty, in acknowledgment of ownership; the residue, however large, being left for the cultivators. This is the only grain with regard to which such concession is shown. This system is known as "Otukapanawa," literally "cutting the tax." It is a significant fact, however, that in the district of Anuradhapura, kurakkan is infinitely more relished than paddy by the mass of the population. It forms their staple product. A proverbial saying goes that in Anuradhapura District, paddy is so lightly thought of, that the "Kurakkan atuwa" is placed in the house and the paddy granary in the garden outside.

For Indian Corn-Bada-iringu (*Zea mays*) and "Mun-eta" (*Phaseolus mungo*) the seed interest is double that of the quantity acquired for propagation. "Muneta" is generally not lent for consumption, and it is the only grain on which compound interest is freely charged.*

In the Four Korales, district of Kegalle, "Muneta" and "Bada-iringu" are generally not grown as single crops, but are inter-sown broadcast in "El-chenas." "Muneta" seed is difficult of preservation owing to insect attacks, which may be prevented by the introduction of lime and "Kohomba" (margosa) leaves and ripe chillies.

The standard measure for "Muneta" and "Kurakkan" is the "Neliya" which is estimated to be equivalent to two chundus.†

Amu, Kurakkan and Bada-iringu take about four months to ripen, while "Muneta" is harvested in about sixty days.

WIND BELTS AND HEDGES.

The following paper received from the St. Andrew's Agricultural Association of Grenada, is reproduced for general information :—

Plants growing in situations which are exposed to wind suffer more or less according to the force of the wind in the particular situation. For this reason it is necessary to provide barriers for protecting cultivated plants and trees in order that we may attain the fullest development and produce their best crops under the most congenial conditions.

These barriers generally take the form of hedges of growing plants and trees of a hardy nature which can withstand the force of the wind, grow to a much greater height than the cultivated plants or trees and have a sufficiently dense foliage from the ground up to the highest branches to form an effective barrier to the wind.

* The custom is prevalent in Four Korales, District of Kegalle. In Kalugammana no interest is charged for "Bada-iringu"; in paddy fields, the land-owner gets ¼ share. Interest in regard to dry grain varies in different districts, but the paddy interest remains all the same in most districts.

† The Kuruni and neli measures are made of rattan, the laha of "Suriya" wood.

These wind belts give protection to the cultivated plants directly, from the force of the wind on their branches and foliage. The cultivated plants derive benefit from wind belts indirectly also in the following ways. Wind belts protect the surface of the soil from the drying effect of the wind sweeping over it, and therefore assist in the conservation of soil moisture; and for the same reason preserves the necessary humidity in the field. Wind belts in preventing the wind from sweeping over the surface of the foliage, benefit the plants by preventing too rapid transpiration from the leaves.

Young cultivation of permanent crops and annual garden crops require more special protection from wind than established permanent cultivation, for the reason that being of a more tender nature and requiring more moisture in the soil, atmosphere and foliage, they suffer more from wind than the older and hardier plants and trees.

Steep mountain lands exposed to the wind deteriorate rapidly after being cleared of forest, unless *wide* belts of forest trees are left to serve as wind belts.

Temporary hedges of quick growing hardy plants are necessary to protect young cultivation until the taller and hardier and slower growing permanent wind belts take their places. These hedges may also be grown in situations where a short growing wind belt is required merely for the purpose of protecting the surface of the soil from the drying effect of the wind. Aralia and hibiscus, which grow under almost any condition to a height of from ten to fifteen feet and retain their foliage throughout the year, are the most suitable for short, quick growing hedges. These are grown from cuttings set in single or double rows at one foot apart.

Among the many kinds of trees suitable for wind-belts may be mentioned Galba (*Calophyllum Calaba*); Mammee Apple (*Mammea americana*), Cloves (*Eugenia caryophyllata*), Honduras Mahogany (*Swietenia macrophylla*), Mango (*Mangifera indica*), Camphor (*Cinnamonum Camphora*), and the Malacca apple tree. All of these make tall, thick, hardy wind belts and Cloves and Camphor are of economic value, the production of which does not interfere with their value as a wind belt. Mammee Apple, Mango and Malacca Apple produce fruit of some value.

As to the best distance at which wind belts should be spaced, a good deal depends on the topography of the land. At the same time it may be stated that for level land 400 feet is a fair distance. The individual trees in the wind belt should be spaced at from five feet to five feet apart according to its wide or narrow branching habits.

In selecting trees for wind belts the planter should avoid growing those which are host plants to insect pests and diseases to which his cultivated plants are susceptible.

It is necessary to isolate the roots of the wind belts by a deep drain or trench, on each side, at about fifteen feet from the stem of the wind belt trees.—Proceedings of Agric. Soc. of Trinidad and Tobago, Vol. XXI, Parts 9 and 10.

PAPER MULCH FOR PINE-APPLE GROWING.

According to a paper read by Mr. A. T. Longley, at the annual meeting of the Hawaiian Pine-apple Packers' Association, experiments have shown that the use of mulching paper materially increases pine-apple production per acre. The idea of a paper mulch for sugar-cane was patented some years ago, but no experiments with pine-apples were conducted until 1919. It is estimated that there are now 461 acres planted in paper, of which 68 acres will fruit in 1922.

The paper mulch appears to consist of a strip of paper in which are cut holes large enough for the pine-apple plants to grow through. The first yields from the method were obtained last year, and according to Mr. Longley it was found that the plants in paper grew uniformly larger, greener, and more healthy, and the fruit larger (equal to a little over 3½ tons per acre) and better conditioned. The paper mulch prevents the growth of weeds and the packing of the soil under heavy rains, thus greatly reducing the cost of intercultivation. In an experiment at the Hawaiian Pine-apple Association's experiment station, the plant growth on paper mulch was three times greater in weight, and much healtheir than on other plots.—Agric. Gaz., N.S.W., Vol. XXXIII, Part I.

AGRICULTURAL STATISTICS, BRITISH INDIA.

1920-21.

Summary tables of agricultural statistics for British India for he agricultural year 1920-21 have been issued.

The total area of British Provinces (excluding Indian States) to which these tables relate is 621 million acres according to professicnal survey, or 618 million acres according to village papers. Of the latter area, 230 million acres represent uncultivable area comprising forests (88 million acres) and other area not available for cultivation (142 millon acres), 115 million acres represent cultural waste other than fallow, and 61 million acres the area left fallow during the year. The remainder, 212 million acres, was the net area actually sown during the year. If areas sown more than once be taken as separate areas for each crop, the total area sown in the year 1920-21 comes to 239 million acres, which is 16 million acres or 6 per cent. less than that of 1919-20.

The total area sown may be classified under the two main heads, food crops (197 million acres) and non-food crops (42 million acres). Except in regard to jawar and ragi, there was generally a decrease in the area under food crops. The noticeable decreases were under gram (-3½ million acres), wheat (-3 million acres), bajra (-2½ million acres), and barley (-1 million acres).

The total area under non-food crops declined by 2 million acres. This decrease occurred mainly in the area under cotton (-1 million acres), and linseed and rape and mustard (¾ million acres, each).

The total area irrigated amounted to 49 million acres, which is nearly he same as in the previous year. The canals irrigated 23 million acres, wells 14 million acres, tanks 7 million acres, and other sources 5 million acres. Including the area sown more than once with irrigation, the gross area of irrigated crops comes to 53 million acres, of which rice occupied 18 million, wheat 10 million, barley 3 million, jawar and bajara 3 million, and cotton 3 million acres.

The figures show that although there was a good increase in the areas under food crops during the War years 1914-18, there has been a considerable fall in this acreage recently and that the area at present is not in excess of the acreage recorded during the decade previous to the War.

MARKET RATES FOR SOME TROPICAL PRODUCTS.

(From Lewis and Peat's Latest Monthly *Prices Current*)

Goods.	Quality.	Price.	Per	Pkgs.	Position.	Market.
Beans and Peas—						
Butter Beans	Madgascar	£12 to £16	ton	Bags	Spot U.K.	More demand
Rangoon Beans	Hand Picked	£ 7 10s to £8	,,	,,	,, ,,	,, ,,
Soya Beans	Manchuria	£13	,,	,,	c.i.f. ,,	Quiet
Copra—	Malabar	£28 10s	,,	,,	c.i.f. U.K.	Steady
	Ceylon	£27	,,	,,	,, ,,	,,
	Straits (F.M.S.)	£25 5s	,,	,,	,, ,,	,,
Groundnuts—	Bombay Decorticated	£19	,,	,,	Continent	Slow
Oils						
Palm Oil	Lagos	£38 10s	,,	Casks	Spot U.K.	Steady
	Congo	£33 10s	,,	,,	,, ,,	,,
Coconut Oil	Cochin	48s	Cwt.	,,	c.i.f. U.K.	,,
	Ceylon	42s	,,	,,	,, ,,	,,
Palm Kernels—	West African	£18 10s	ton	Bags	Ex quay L'pool / spot U.K.	,,
Seeds—						
Sesame Seed	Bombay	£21 10s to £22 10s	,,	,,	c.i.f. U.K.	Steady, but quiet
Castor Seed	Bombay	£16 10s	,,	,,	,, ,,	Steady, but quiet and inactive
	Madras	£16	,,	,,	,, ,,	,, ,,

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 28th FEBRUARY, 1922.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st. 1922.	Fresh Cases	Recoveries.	Deaths.	Balance Ill.	No. Shot.
Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	100	29	87	—	13	—
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	(Destroyed)		—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	115	14	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	6	4	—	—	—	—
Cattle Quarantine Station	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	19	8	—	—	—	—
	Anthrax	51	27	—	—	—	—
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	—	1	—	—	—
	Anthrax	—	—	—	—	—	—
	Piroplasmosis	6	—	6	—	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	6	—	6	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	8	—	2	6	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	294	—	294	—	—	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest						
	Foot-and mouth disease		Nil				
	Anthrax						
North-Western	Rinderpest						
	Foot-and-mouth disease		Nil				
	Anthrax						
North-Central	Rinderpest						
	Foot-and-mouth disease		Nil				
	Anthrax						
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	78	37	67	—	11	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	220	92	184	—	35	—
	Anthrax	—	—	—	—	—	—

G. W. STURGESS,
Government Veterinary Surgeon.

Colombo, 6th March, 1922.

METEOROLOGICAL.

FEBRUARY, 1922.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of cloud 0=clear. 10=overcast	Mean Wind Direction during month	Daily Mean Velocity.	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from Average
	°	°	%			Miles.	Inches		Inches
Colombo Observatory	79·8	0	78	5·0	NNW	120	2·12	6	+ 0·30
Puttalam	78·6	0·	79	4·2	NNE	137	3·91	7	+ 2·68
Mannar	79·6	- 0·4	77	5·4	NNE	191	14·75	7	+13·71
Jaffna	78·2	- 0·8	82	5·6	ENE	126	5·23	10	+ 4·09
Trincomalee	79·8	- 0·6	78	6·0	ENE	178	3·04	9	+ 0·97
Batticaloa	78·4	0	85	4·0	NNE	194	5·52	9	+ 2·21
Hambantota	79·2	+ 0·2	78	4·2	ENE	284	1·63	8	+ 0·16
Galle	79·4	0	81	4·8	Var.	129	3·16	6	+ 0·45
Ratnapura	81·4	+ 0·4	74	5·6	—	—	6·73	11	+ 2·35
Anu'pura	77·8	- 0·2	81	5·9	—	—	7·68	9	+ 6·24
Kurunegala	79·2	- 0·8	76	4·8	—	—	4·16	9	+ 2·62
Kandy	76·4	+ 0·4	74	5·2	—	—	3·24	9	+ 0·99
Badulla	71·0	+ 0·1	82	6·6	—	—	2·97	12	- 0·11
Diyatalawa	65·6	0	79	5·7	—	—	2·45	15	- 0·05
Hakgala	58·0	+ 0·1	91	7·4	—	—	6·78	11	+ 3·63
N. Eliya	58·1	+ 0·6	78	6·6	—	—	2·55	9	+ 0·49

The chief meteorological feature of the month was the depression that passed over the Island on the 11th-14th. Its course was roughly north-westerly from Kalmunai through Vakaneri and Vavuniya, to Mannar and the rain was concentrated on a narrow strip with a sharp decrease in amount within a few miles on each side of it. On the 12th-13th (the day of heaviest rainfall) along the centre of the trouble the figures include Vakaneri 8·0 inches, Sangilikancarawa 7·8, Kebitt. goleewa 7·8, Vavuniya 8·5, Puvarasankulam 10·3, Cheddikulam, 1·0, Mantota 11·6, Mannar 11·2.

Northward the fall off is shown by Puliyankulam 7·8 inches, Mankulam, 6·8, Killinochi 2·3, and Southward by Anuradhapura 5·4 inches. Nechchaduwa 4·5, Maradankadawala 2·7 and Illuppalama 2·8. Further south about half the stations in the island recorded nothing at all and on the next day less than half an inch was recorded at most of the stations that had been in the centre of the previous day's downpour.

As regards monthly totals, most of the stations in the northern half of the island have but small averages in February, and passed them this year with a good deal to spare and in many cases February 1922 is the wettest February on record. It is noteworthy however that though many of these stations recorded over 10 inches in a day none of them reached 15 inches for the month.

In the southern half of the island, even without the help of torrential rain on the 12th, more stations were above average than not. Round the outer shoulders of the main hills a loose ring of stations can be found at which this excess was over 5 inches, including Arapayake, Yatideriya, Watawala, Carney, Koslanda, Udahena and some stations in the Rangala, Matale North and Pussellawa districts. Within this loop the commonest offsets were of the order of plus 2 inches, though a few stations were below average e.g. in Maskeliya and the Welimada-Diyatalawa hollow.

Of the other areas that failed to reach their average the most definite was in the Southern Province, notably south of Denivaya: others were in the northern half of the Western Province, in parts of Uva, and the southern part of the Eastern Province. As will be seen from the table the temperature variations were not large and were roughly speaking, negative in the north and positive in the south.

Pressure was lower than usual and the gradient steeper which fact also shows in the mean wind velocities which were higher.

Humidity and amount of clouded sky were also both slightly above average.

A. J. BAMFORD,
Supdt. Observatory.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MARCH, 1922.

Province, &c.	Disease.	No. of Cases up to date since Jan. 1st 1922.	Fresh Cases	Recoveries	Deaths.	Balance Ill.	No. Shot
Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	173	13	106	1	6	—
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	(1 destroyed)	—	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	122	7	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	6	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	40	21	—	—	—	—
	Anthrax	74	23	—	—	—	—
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	—	1	—	—	—
	Anthrax	2	2	—	2	—	—
	Piroplasmois	6	—	6	—	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	6	—	6	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorhagic Septicæmia	35	27	4	31	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	294	—	294	—	—	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest						
	Foot-and-mouth disease		Nil				
	Anthrax						
North-Western	Rinderpest						
	Foot-and-mouth disease		Nil				
	Anthrax						
North-Central	Rinderpest						
	Foot-and-mouth disease		Nil				
	Anthrax						
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	123	45	110	—	13	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	290	70	234	—	56	—
	Anthrax	—	—	—	—	—	—

G. W. STURGESS,
Government Veterinary Surgeon.

Colombo, 5th April, 1922.

METEOROLOGICAL NOTES.

(Continued from next Column.)

The 28th was certainly the most interesting day, as on it, for the first time this year, an upper wind from the South-west was recorded (compare the reference above to Bandaragama on that day) which was followed on the 29th by a temporary, but very typical change in the general condition on the west coast.

Like the rainfall the amount of cloud was in general below average. Temperature was above average at most low-country stations but below it at the up-country ones, thanks chiefly to low night temperatures associated with the lack of cloud referred to above. Humidity was on the whole above average at the hill stations and below it at the coast.

A. J. BAMFORD,
Supdt. Observatory.

METEOROLOGICAL.

MARCH, 1922.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud (0=clear 10=overcast)	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	81·6	+ 0·2	80	4·6	WSW	94	1·63	5	- 2·69
Puttalam *	80·6	- 0·6	78	2·0	WSW	123	—	—	—
Mannar	82·8	- 0·2	76	2·6	Var.	170	0	0	- 1·35
Jaffna	82·9	+ 0·1	73	2·7	SE	189	0	0	- 1·01
Trincomalee	82·7	0	—	—	—	—	0·42	2	- 1·08
Batticaloa	81·0	+ 0·2	80	2·0	ENE	159	0	0	- 2·94
Hambantota	81·3	+ 0·9	74	2·0	ESE	207	0·52	4	- 1·70
Galle	80·8	- 0·4	78	4·0	SW	128	2·45	9	- 1·71
Ratnapura	82·4	+ 0·2	74	4·2	—	—	9·97	21	+ 1·46
Anuradhapura	82·6	+ 0·6	71	3·4	—	—	0·48	4	- 2·20
Kurunegala	83·2	+ 0·2	70	3·3	—	—	3·22	4	- 2·62
Kandy	78·7	+ 0·3	72	3·9	—	—	2·97	7	- 0·85
Badulla	73·4	0	76	4·1	—	—	0·41	4	- 3·94
Diyatalawa	66·8	- 1·0	75	3·9	—	—	1·62	4	- 2·54
Hakgala	59·6	- 0·6	90	4·6	—	—	1·70	3	- 3·51
N. Eliya	56·7	- 2·5	77	5·0	—	—	1·79	5	- 1·54

* 18 days observations.

Throughout almost the whole of the island the rainfall in March 1922 was below normal. By far the commonest deficits were from 2 to 5 inches, though north of Anuradhapura they were consistently smaller than this, for the simple reason that in that area the March averages are themselves less than 2 inches. Deficits of over 5 inches though less frequent, occurred in a variety of districts in the southern half of the island, the area most affected being roughly defined by Colombo, Kegalle, Kurunegala, though there was another marked group in the centre of the Southern Province.

In several of these cases the rainfall for March 1922 was the lowest on record for the month of March—an interesting point when taken in connection with the fact that only last month a number of stations in the north of the island were abnormal in the other direction and broke their maximum records for February.

Looking next at the few stations which reached their average, Kalutara is noteworthy since with the help of 3·39 inches on the 21st/22nd it passed its monthly average by 2·7 ins. Embilipitiya (in extreme South East of Sabaragamuwa) and Monaragala (Uva) also passed their average by more than 2 inches and both received most of their rain in the early part of the month, not by far the 9th—11th. Others that reached their average were Kalpitiya, Negombo, Yatiyantota, Digalla, Bandusejour, Mamadola and Kumbukkan. Reference must also be made to Bandaragama's 7·15 inches on the 7th/8th—as this is a comparatively new station it has no average yet with which to compare its current figures.

In terms of absolute rainfall, irrespective of averages, the chief items to comment on are first the large number of stations in the Northern and Eastern Provinces that measured no rain at all, and secondly the distribution of the (few) stations that recorded over 10 inches, the majority of which lie in a belt stretching southward from Yatiyantota through Sunderland, Eheliyagoda and Keragala to Carney just North of Ratnapura.

Other reports of over 10 inches include Hiniduma and Meeriabedde (on the outward slope, south east from Haputale). As regards the variation of type during the month, a slight pressure gradient from the north at the beginning weakened in the middle, and was followed by a mild distribution of the kind associated with local evening thunderstorms, an example of which has already been quoted in the reference to Kalutara.

CENTUARY OF THE ROYAL BOTANIC GARDENS, PERADENIYA,
Staff of Department of Agriculture.